HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #56

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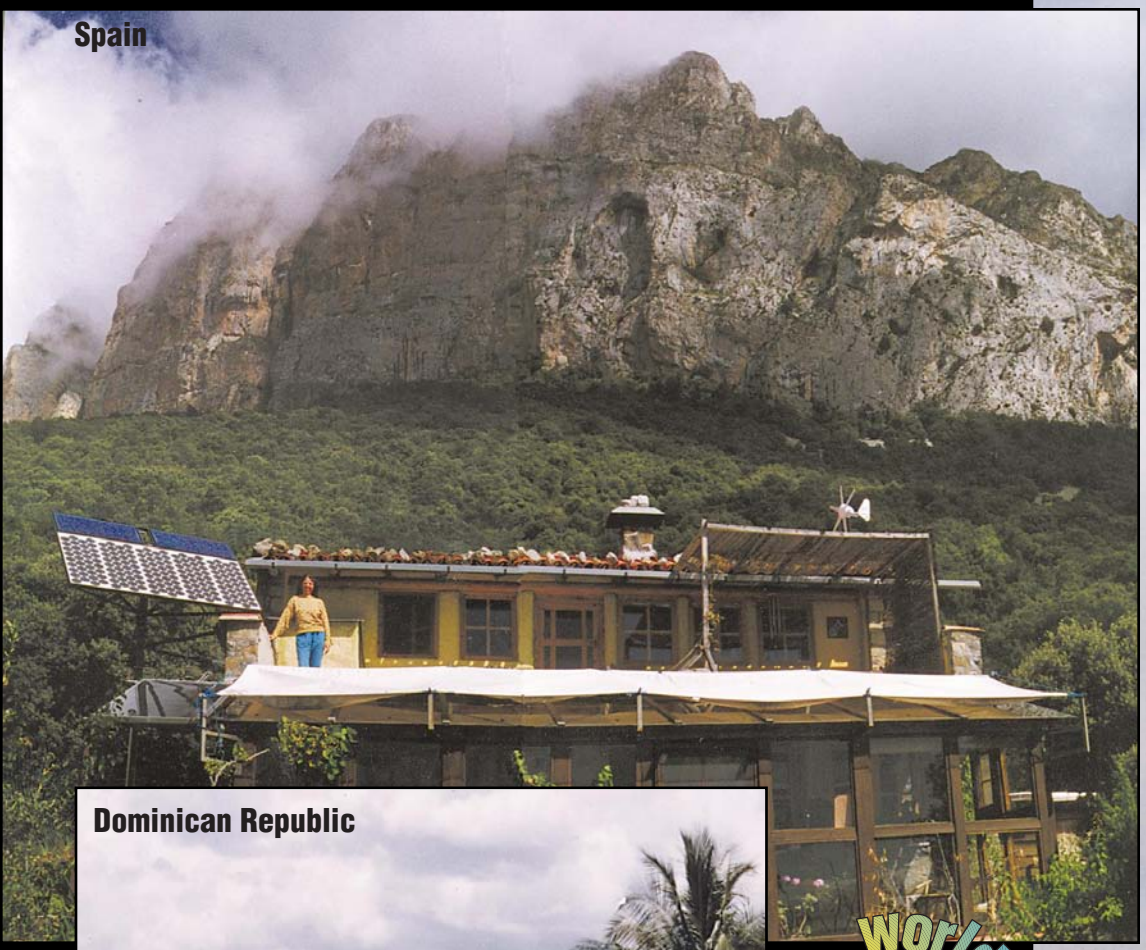

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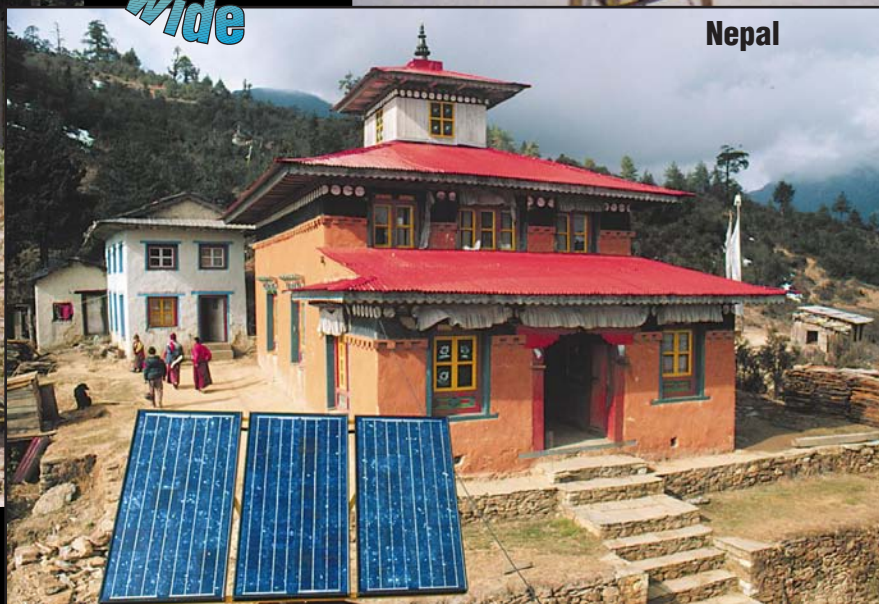

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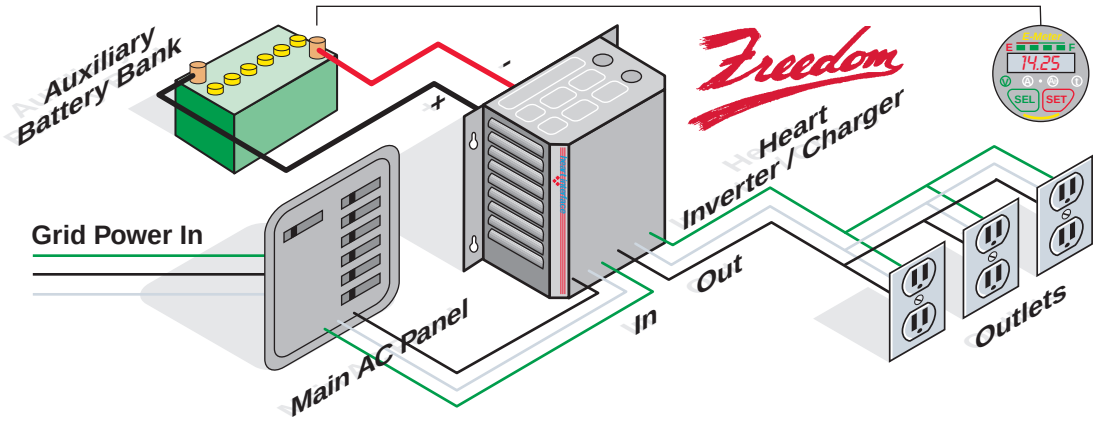

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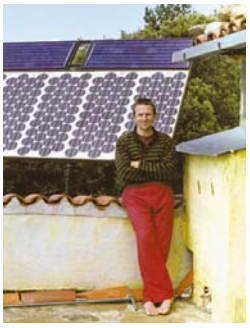
Features



GoPower

Fundamentals

Features

Cover: Renewable energy takes hold world wide; flexible technologies meeting diverse human needs.

Homebrew

Columns

Regulars

Access and Info

Access Data

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Catching Rainbows

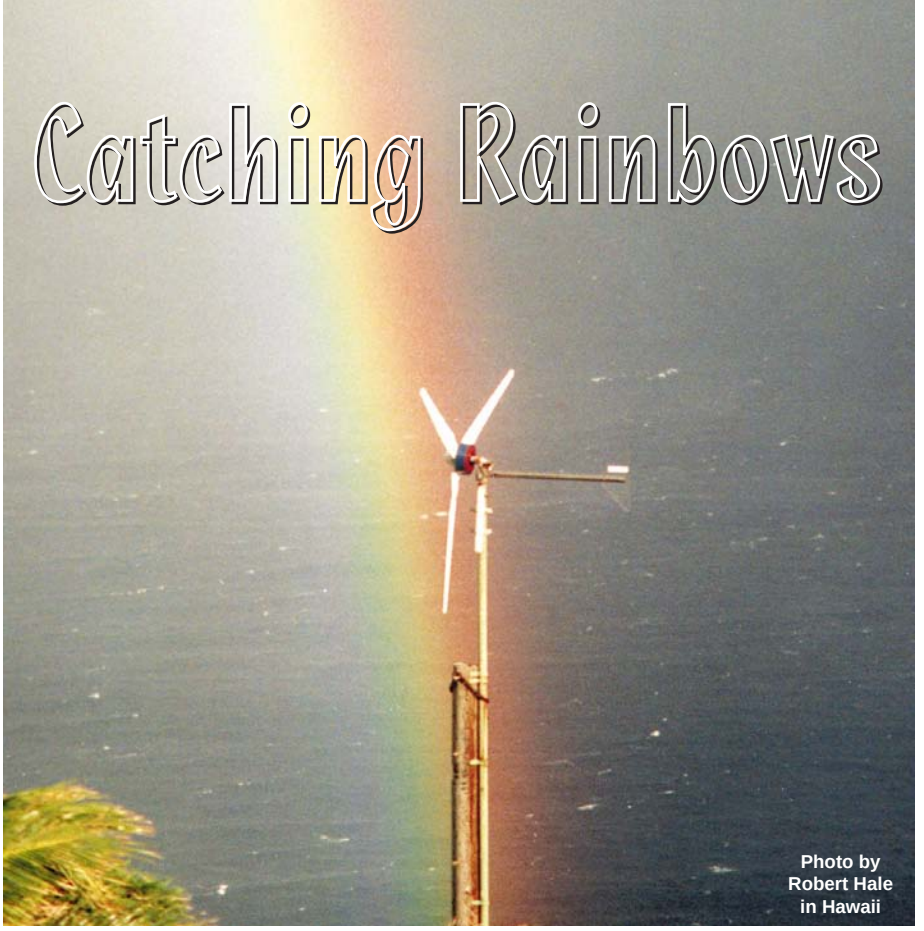

Photo by Robert Hale in Hawaii

Sometimes if we chase rainbows hard enough, we can catch one!

The City of Ashland, Oregon is the first municipal utility in the United States of America to offer an incentive to utility-connected, renewable energy producers. Not only does Ashland welcome solar and wind energy producers to put their surplus power on Ashland's grid, the City of Ashland will pay a premium for the renewable energy!

On 2 October 1996, the City of Ashland passed resolution No. 96-42 which states (and I quote):

"The City of Ashland encourages citizens and businesses to invest in renewable electric energy generation systems, and for those who generate electricity, to remain on the electric grid to use it as a backup supply. This policy is designed to provide adequate incentives to encourage renewable generation while remaining on the city's electric grid."

The City of Ashland will pay the RE producer **1.25 times** the highest residential rate for the first 1,000 kWh each month which the RE producer sells back to the municipal electric grid. These utility intertied RE systems will be installed using sensible and realistic safety guidelines, will use a single, bi-directional, kWh meter (provided by the City of Ashland), and are available to both business and residential utility customers.

We congratulate Ashland for being the first city in America to realize the value of renewable energy. We salute energy activists Risa Buck (see cover story HP#48), Dick Wanderscheid (Conservation Manager, City of Ashland), and Catherine M. Golden (Mayor of Ashland) for helping make this possible. We, at *Home Power*, are so proud of them that we could explode!

If you want more info on Ashland's RE policy, or if you just want to send them flowers, contact: Dick Wanderscheid, Ashland City Hall, 20 East Main Street, Ashland, OR 97520 • 541-488-5306 • FAX 541-488-5311.

Richard Perez for the Whole Home Power Crew

People

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Richard Perez
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Dennis Ramsey
Benjamin Root
Bob-O Schultze
Michael Welch
John Wiles
Myna Wilson
Alfred Zirkel

" Think about it…"

"It's gonna rain off and on… for the rest of our lives."

Joe Schwartz
while building on Agate Flat

SOLAR DEPOT

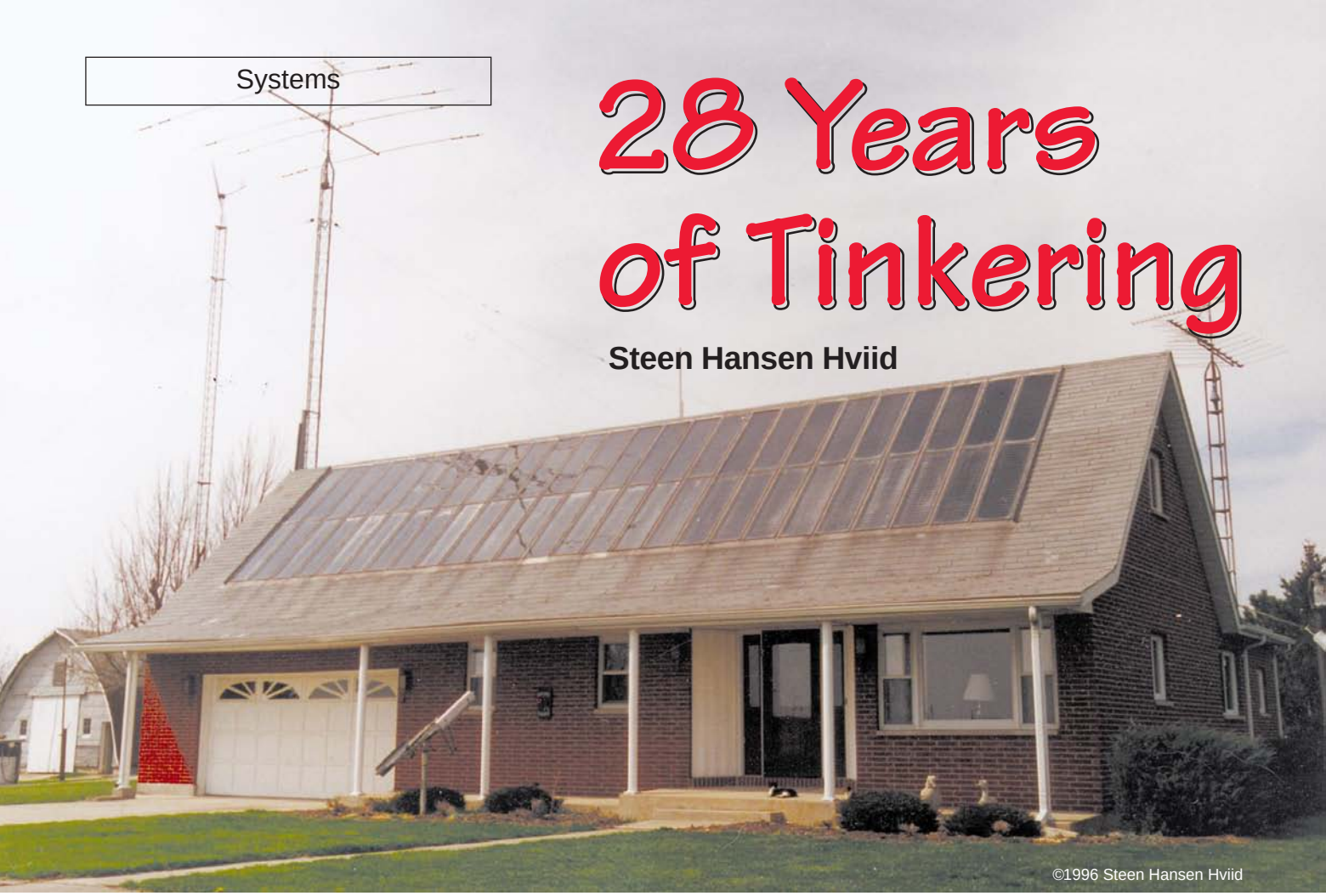
four color on film

full page, bled

this is page 5

28 Years of Tinkering

Steen Hansen Hviid



This past Earth Day, I went to visit Ann and Walther Vogel, who live in St. Marys, outside Lima in northwestern Ohio. They built their own 1,767 square foot house in 1977, after a fire that completely destroyed the old house. Walt Vogel had become interested in renewable energy in the late sixties, so they decided to use solar energy in the new house right from the start. The energy crisis was still fresh in memory and generous tax write-offs were available. The house and outbuildings bear witness to Walt's love of tinkering with things—pieces of homemade electronics and solar devices are everywhere, and he can proudly show pictures of his two hand-built airplanes.

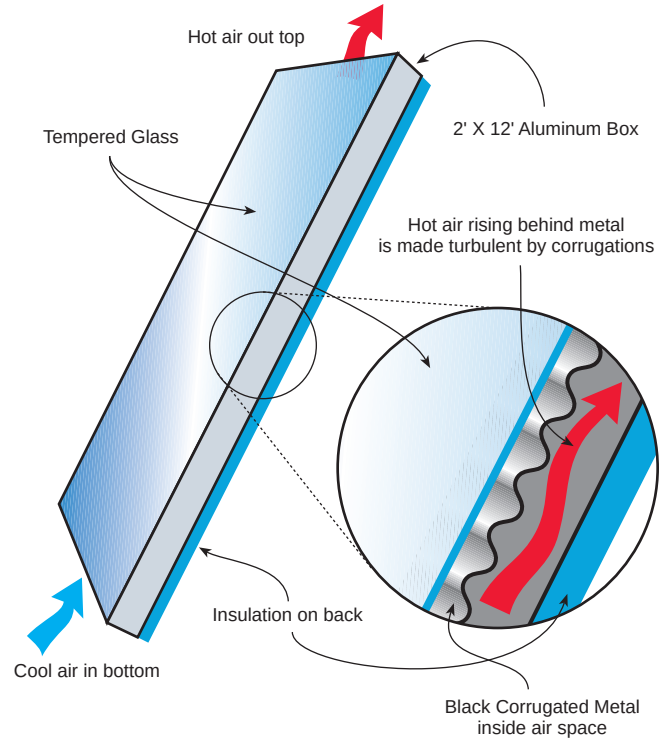
Their house is clearly visible from the highway and people often stop to gawk at the equipment arrayed in front. Some get so curious they knock on the door to hear the story. He estimates a thousand people have gotten tours over the years, including 300 people the day they had an open house as part of a tour of the county arranged by a local university extension service.

Heating the House

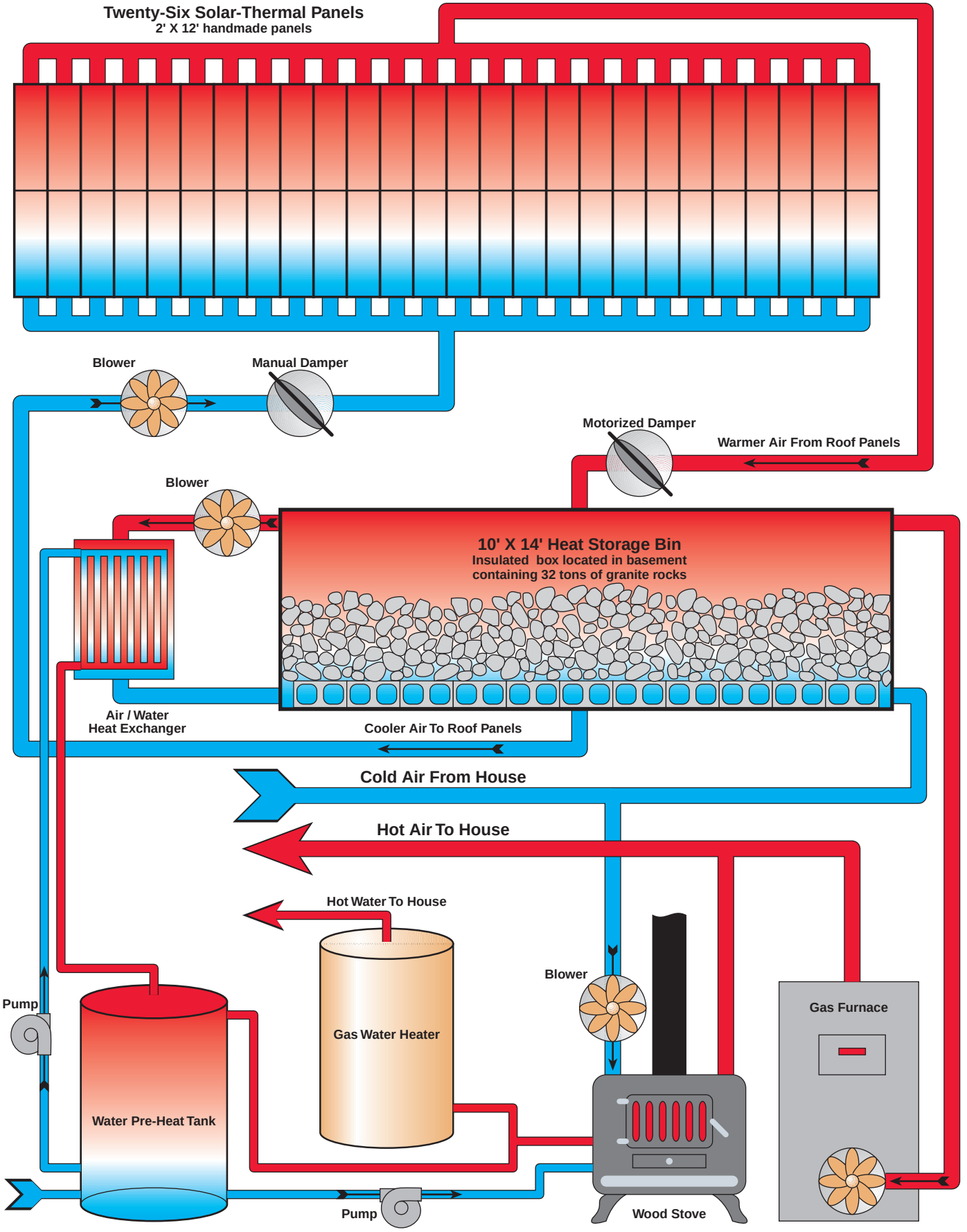
A 624 square foot solar collector for heating air covers most of the roof. The collectors are an integrated part of the roof made of aluminum boxes that fit between the rafters. Unfortunately, some of them leak as they are hard to keep tight when the metal expands and contracts with temperature changes. Each box is covered by tempered glass and contains a piece of black painted corrugated roofing material as an absorber. He settled on this design after trying out several methods. A blower in the attic pushes air into the bottom of each panel and out through the top. The air travels behind the corrugated absorber, which makes it turbulent to transfer the heat better. The heated air continues down to the basement where a bin absorbs the heat before returning the air to the collectors. The heat storage is a large insulated box containing 32 tons of granite rocks. Granite was chosen for its good energy density and ability to transfer heat.

The storage is a custom made bin 10 by 14 feet, built with 2 by 6 inch studs. The studs are spaced six inches apart, making the wall strong enough to hold the rocks. The six inch hollow in the wall contains cellulose fibre (ground up newspapers) treated with fire-resistant chemicals as was common in those days. The walls are made of half inch plywood with one inch Thermax polyurethane foam. A layer of aluminum foil on each side of the Thermax reflects the heat. The bottom of the bin is made from eight inch hollow cement blocks, through which the heated air enters. On top of these blocks is the five feet of granite rocks. A hatch allows inspection of the rock bin. Ann occasionally uses it to raise dough, which makes the whole house smell nice! The storage can provide the house with heat for about two and a half days without sun at an outside temperature of 30°. While we were there it was sunny and about 70° outside, while the heat storage was at 127°. A two inch fiberglass filter on the bin intake prevents most dust from entering. An electrostatic filter sits on the outtake, before the air goes through the backup gas furnace and into the house. A wood stove can also be used to heat the air during cold winters. Thermostats control the blowers and the furnace, making the system fully automatic so they can go on vacation and not worry about the system. The only manual operation is a damper used twice a year to turn the rock bin off for the summer and back on in the autumn. Hot water is generated in a tank next to the storage with a heat exchanger. The water then passes through a gas water heater which automatically makes sure the water is hot enough. In the summer the solar collectors are turned off and the gas heater is used exclusively. The reason is that the heat loss through the thick walls of the heat-storage is still so great it makes it impossible to cool the house. The cost of the electricity

Above: The attic where cool air enters the hot air collectors.



Below: Looking through the hatch into the rock bin.


Twenty-Six Solar-Thermal Panels
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Manual Damper
Motorized Damper
Warmer Air From Roof Panels
Blower
10' X 14' Heat Storage Bin
Insulated box located in basement
containing 32 tons of granite rocks
Air / Water
Heat Exchanger
Cooler Air To Roof Panels
Cold Air From House
Hot Air To House
Hot Water To House
Blower
Pump
Gas Water Heater
Gas Furnace
Water Pre-Heat Tank
Pump
Wood Stove

running the blower for the heat exchanger is also higher than the cost of the gas to heat the water. When the system is turned back on in late August, he lets the rock bin heat up over a few days, while venting it, to kill the mildew that has grown during the humid summer. Walt had tinkered a bit and decided water-based systems were too impractical. If an air-based system leaks, one can simply tape over it. If a leak develops in a water-based system, it can create a mess, the system has to be drained before patching it, and it is harder to keep tight. The heating system was built with the house in 1977 for $6000, and has worked flawlessly ever since. Walt estimates that it took eight years for the system to pay for itself in saved fuel costs. There was much more interest in these systems in the late seventies. From 1977 to 1981, Walt built 34 systems for other people. Most only provided hot water, though some were large hot-air systems like his own. Most are still in operation. Walt later exhibited at local county fairs, offering his services, but interest was very limited.

Heating the Workshop

A garage which houses the office / workshop and battery banks is heated most of the year with a simple solar air collector. It is a four feet high, six inches deep, and 16 feet wide aluminum box. The front is semi-transparent fiberglass and the insides are filled with the same metal mesh used in the air filters above stoves. The panel is mounted on the south wall outside. A blower moves inside air into the bottom of the panel. The hot air goes out the top of the panel, through a duct hanging under the ceiling, and ends in the center of the shop. Since the hot air can rise on its own, some heat is generated even without the blower.

Below: The hot air collector for Walt's workshop.

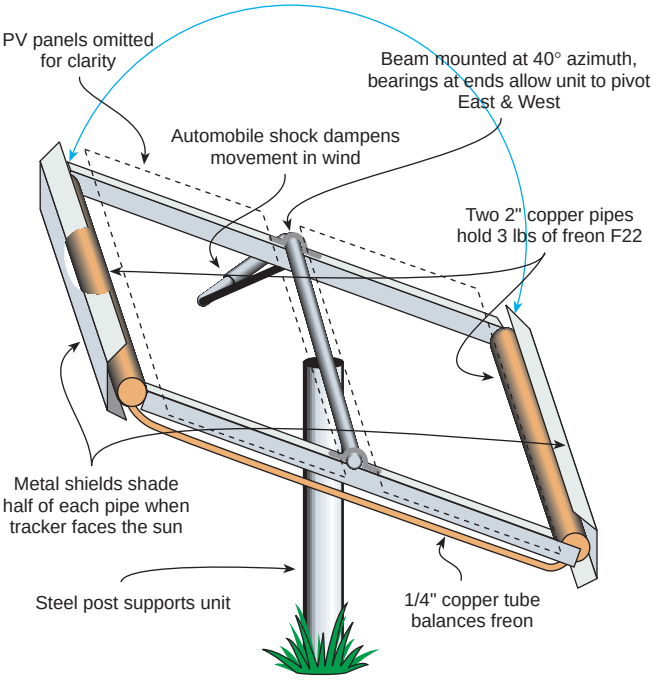
The Photovoltaic Panels

The first few PV panels were bought in 1977. More were added as finances allowed. There are now 30 Arco M61 panels, each generating up to 43 Watts. The panels have become browned by many years in the sun, but they are still working fine. Six panels are mounted on each of five trackers. The trackers deliver 24 Volt DC and are connected in series to the 120 Volt battery bank. A sixth tracker is placed in front of the house as a separate system for ham radio. Once a year, it also powers a ham radio in the field during ham field day. Teams powering their systems by renewable energy gain extra points. The trackers are home made, of course. A beam is mounted at an angle of 40° on a steel post. At each end of the beam is a ball bearing where the panel rack is mounted. At the top is an automotive shock absorber used as a damper to prevent the tracker from swinging back and forth too much in the wind. A 2 inch copper canister with freon-22 is mounted at each end of the rack. A 1/4 inch copper tube connects the canisters, so the freon can travel between them. The entire system contains 3 lbs of freon. Had it been built today some other gas may have been used instead. Each canister sits inside a half-cylinder shield. When the rack points directly at the sun, the shield covers exactly half of each cylinder. If the rack is not pointing directly at the sun, the canister at the end that is pointing away (down) will be less covered by the shield. The canister at the other end of the rack, pointing more toward the sun (up), will be covered. The difference makes the less covered canister warmer and the more covered canister cooler. In the warmer canister the freon expands and moves to the cooler canister making the warmer one lighter. The cooler canister becomes heavier. The rack will turn a little until it points toward the sun, and the temperature in the two canisters is again roughly the same. I have always wondered how this purely mechanical tracker worked, and now I know! They are maintenance free, except a drop of oil in the bearings a few times a year. They are sluggish in the cold, and flop a bit during a storm, but they are very sturdily built.

The Wind Generator

The seventy foot tower was originally erected for a 3 kW Jacobs Skyhawk wind generator. The Jacobs was taken down a few years ago and replaced with a 1 kW World Power. It delivers 3 phase ac at 120 volts, which is rectified to DC before

Above: Walt's front walk showing solar thermal panels on the roof and the photovoltaic array powering his HAM radio system.

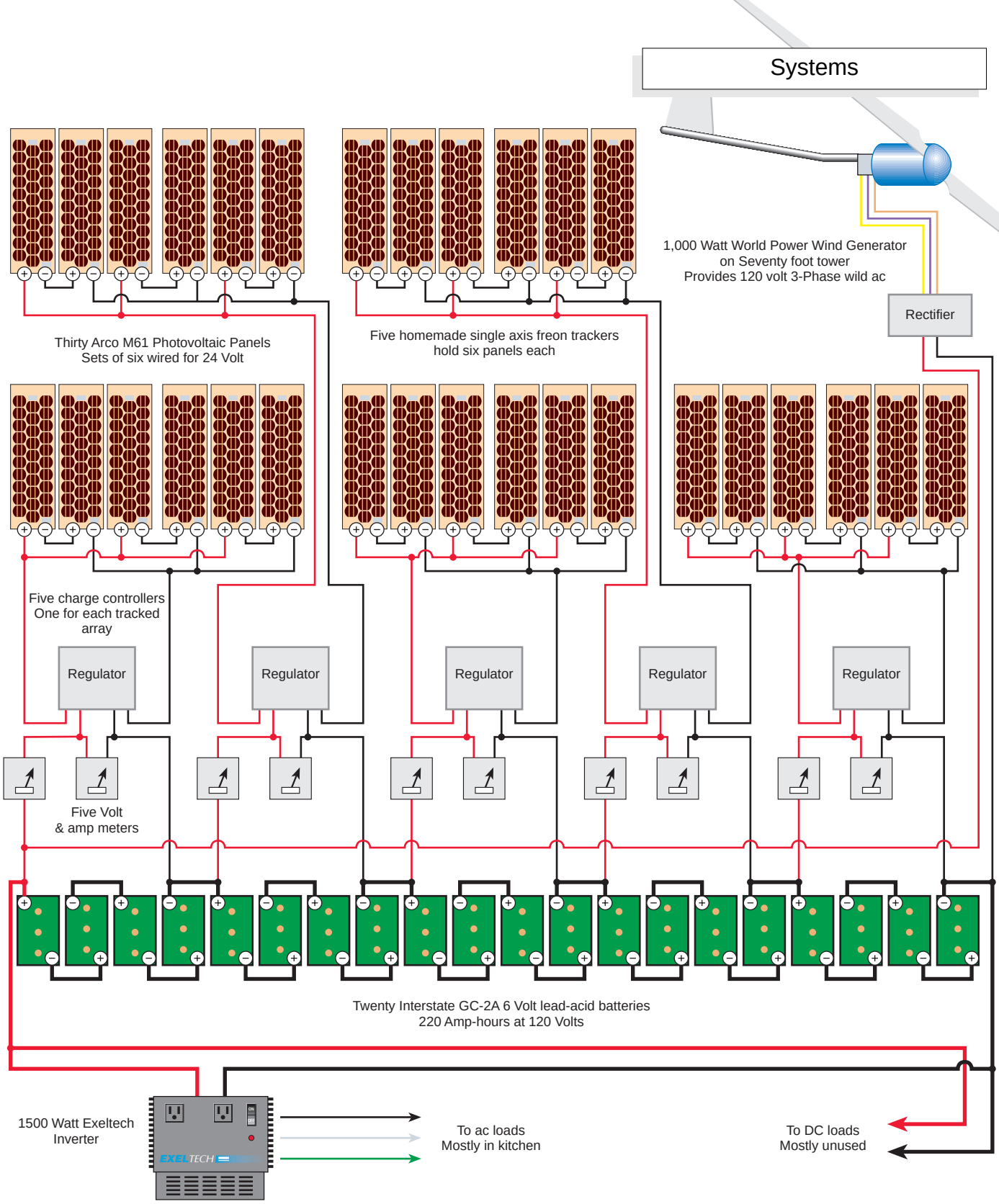


going to the battery bank. Walt estimates that the generator will pay for itself in about six years. The blades on the new mill were originally of wood and were recently changed to fiberglass, which is more efficient. Too efficient, actually, since the bearings now run too hot and boil off their grease. A storm had come through in the days before our visit. It overloaded the bearings, so the mill was hardly turning, despite a good wind. A previous storm left the area without electricity for five days. The house had fine light, while the neighboring houses were all dark.

The Battery Banks

The main battery bank is located in the office / workshop and consists of twenty 6 Volt lead acid batteries wired for 120 Volt DC. They are Interstate GC-2A golf-cart batteries, with a capacity of 220 Amp-hours. They are covered by a sheet of plastic and vented to the outside via a pipe that goes to the chimney, thus using the natural draft in the chimney. A set of two wires come in from each of the five trackers, with a separate charge controller for each. The charge controllers used to be

Left: Twenty-four of the thirty PV panels that are connected at 24 Volt increments to Walt's 120 Volt DC battery bank. In the background is the 1000 watt wind generator.



home made, but have now been replaced with commercial ones. The batteries power an Exeltech 1500 watt inverter that supplies the kitchen section of the house. The kitchen has a regular refrigerator, food mixer, electric skillet, and a range of smaller appliances. The rest of the house is powered by the grid, except for a few 110 Volt DC outlets, which are seldom used. This is the fourth inverter to serve this system. Each new model was smaller, cheaper and better, though the present one had just given out a few days before. Walt has a longstanding relationship with the folks at Exeltech, who supplied all the inverters. They have tried to convince Walt to convert to a 24 Volt system, but he prefers the higher voltage to cut down on line loss.

Above: Walt explains the single series string of twenty 6 Volt golf cart batteries which provide 220 Ampere-hours of storage.

Utility Intertie

The solar / wind system delivers about a third of the total annual electricity. The system was briefly connected to the grid in 1980, with the Rural Electrical Cooperative paying for any excess electricity at 2 ¢/kWh and selling it at 6.1 ¢/kWh. A souvenir from the first month of electricity surplus is a $3.81 check from the utility. That became the only check, since the utility company then decided to end the cooperation. They increased the demand for insurance, which was initially $100,000, and kept going up until it was unaffordable and Walt had to disconnect from the grid. Today, the renewable energy system is totally separate from the utility. A manual transfer switch determines what delivers electricity to which part of the home. Walt showed his homemade transfer switch, which consists of two regular two-poled breakers, one of them mounted upside-down, with their levers bolted together. When the lever is down, the kitchen is powered from the battery bank by means of the left breaker. When the lever is up the utility supplies the electricity, through the right breaker box. It's a very simple system, which costs much less than a commercial transfer switch. The local inspector did inspect and approve this setup.

Below: Walt shows his homemade tracker to a visitor.

Other Experiments

Walt and a friend once saw a hydrogen powered car and thought they should also build one. They started out by generating hydrogen by electrolysis, but a couple of explosions made them put those plans on the shelf. Walt is now retired from his job as a lab technician at the local Goodyear plant, and spends most of his time tinkering with radios and airplanes. A car engine was in the shop, ready to be put into a small airplane and a few solar experiments were scattered outside the shop.

Access

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ANANDA POWER TECHNOLOGIES

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Renewable Energy & Community Water in the Dominican Republic

Mark Johnson

The Place that Columbus Always Loved the Best. That is what the Dominicans will tell you about the Caribbean island of Hispañiola, shared between Haiti, which occupies the western third of the island, and the Dominican Republic. Hispañiola's 10,000 foot mountains are the highest in the Caribbean, and the sun drenched Dominican beaches attract millions of tourists annually. The abundance of sunlight and the remoteness of one the Dominican Republic's westernmost villages combine to make an ideal setting for a rural community water system using renewable energy.

Although the island possesses some of the oldest known European settlements in the western hemisphere, the Dominican Republic is struggling to provide food, education, and basic health services for its 7.5 million inhabitants. In response to this need, the Dominican government has accepted the assistance of numerous international organizations.

One of them is CARE, a non-profit disaster and relief organization with missions in over 60 lesser developed countries worldwide. At the end of World War II, CARE began by sending simple foodstuffs to needy victims of the long European conflict in what became known as "CARE packages." Since that time, CARE has grown into an international development organization. It provides assistance to residents and government institutions of developing nations in the fields of agriculture and natural resources, health, disaster mitigation, and rural and urban infrastructure.

For over thirty five years, CARE has been present in the Dominican Republic executing such projects as school feeding, maternal/child health, family planning, urban infrastructure, and disaster mitigation programs. In early 1995, CARE started a rural water and sanitation program in the western part of the country, where the child mortality rate is 69 deaths per 1000 children under the age of five. Loss of life due to dehydration is listed as one of the primary causes of death in Dominican infants. The dehydration comes from excessive diarrhea, a result of poor access to clean water and sanitary facilities.

In October of that same year, CARE was contacted by an organization funded by the European Union known locally as PRISA (Southwest Integrated Health Project) and asked to perform a feasibility study for a water project in a small community located near the western Dominican border with Haiti. The community members from Cañafistol (kanya-FEAST-ol) had approached various organizations with the hope of finding one

Above: Drilling for water at the initial (unsuccessful) well site. A second location provided more than enough water for the 546 residents.

willing to address their problems. They were in the process of securing funds from PRISA for a latrine project and were determined to resolve the issue of their lack of access to potable water.

Cañafistol is located close to the geographic center of the island in the province of San Juan, and credits its name to a type of tree that was once found in the area. The 88 homes of the predominantly farming community are scattered along the base of a ridge, which over time has forced a nearby river to carve an “ox-bow” around the area. Being bordered by the ridge on the east and the river on the north, west, and south, the community members are left with no other option but to ford the bridgeless river to enter or leave the community.

The river has provided the 546 residents of Cañafistol with fertile bottom land for planting and water for their irrigation canals. It was also their main source of drinking. They used the canals for bathing, laundry, and washing dishes, but would walk to the river’s edge twice a day to collect and carry water back to their homes for consumption. In addition to the dangers of drinking surface water of unquestionable poor quality, the task of just collecting the water would often take many hours a day. Due to cultural expectations, this chore was usually performed by the children or female members of the household.

When the residents of Cañafistol were asked to identify their most immediate needs, they listed access to safe drinking water as the priority. Improved sanitation facilities, agricultural extension programs, and better roads all shared the number two spot in terms of importance.

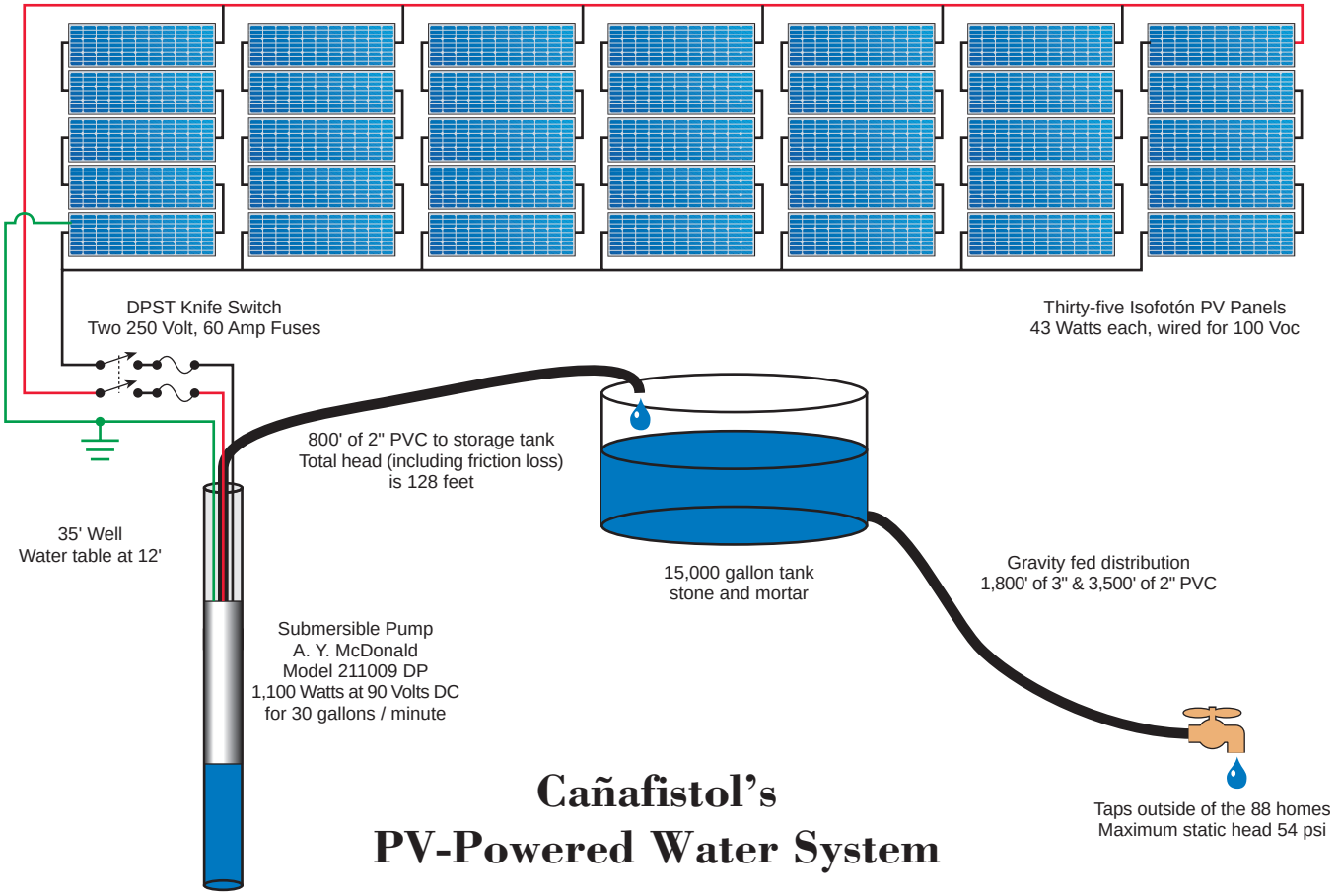
Design Options

When investigating the feasibility of a rural water system for a community, it’s important to consider one that is easy to build and maintain, since the community members will construct and assume ownership of it. It should incorporate as few moving parts as possible, and take advantage of local skills and building materials. CARE staff analyzed all available options with the community and the donor, and for the following reasons determined that a PV powered direct, submersible pump was the most sustainable solution.

Gravity Flow

This would be the first choice for a rural water system. Find a clean water source, hopefully a mountain spring with sufficient quantity to serve future population growth, convey the water to a storage tank, and distribute it to the users. The only moving parts are a few valves and the water itself. Unfortunately, the only surface water available near Cañafistol is the river. Due to the gentle slope of the river, one would have to impound it at a distance of over three miles upstream in order to be at a higher elevation than the tank site. Some form of treatment would be necessary as well, which would require additional training and maintenance.

Below: All generations helped with the water project. Here the Mejía family digs the distribution ditch in front of the homes.



Surface Water

Pumping water from the same river to the tank site, but from a spot closer to the community, was also an option. The advantage being that the "pump" could easily be a series of hydraulic rams or hydro turbines, which could be fabricated from locally available materials. However, this did not eliminate the need for some form of treatment.

Groundwater

The advantage of a meandering river similar to the one that passes by Cañafistol is that there is usually a fairly high water table in the sediment plains formed by the river. The quantity of water available is dependant on soil conditions, but the quality rarely requires treatment. Therefore, if a site with the right conditions were to be found, renewable energy could be used to pump the groundwater directly to a storage tank for distribution.

Well Drilling

Two sites were chosen to drill exploratory wells. The first site was close to the center of the village and the proposed tank location. The well turned out to be much deeper at this site, but its vicinity to the village was favorable and it had potential as a wind power site. Unfortunately, there was not enough water to be found to satisfy the needs of the community. The water table was estimated to be at 50 feet, but a layer of blue clay was found which started at 35 feet and was still present at 70 feet. This type of material is almost impervious to water, so the well was filled in and the equipment was moved to the second site.

The second site was located approximately 600 feet before the entrance to the village in the sediment plain of the river. There was little doubt that the necessary quantity of water would be found at this site. Before contracting a well driller, the community members had dug a six foot diameter well by hand and hit water at a depth of 12 feet. They found so much water that they were unable to dig beyond a depth of 15 feet, even with the aid of a pump extracting a flow of 60 gallons per minute.

After drilling through the first five feet of rich vegetative layer, the driller encountered 30 feet of river rock, sand, and gravel, with the water table at 12 feet. At a depth of 35 feet, he hit the same blue clay and decided to stop. The well was cased with eight inch steel pipe which was left over from another water project. The pipe had

slots burned into it between the 15 and 30 foot depths. The slots are sized and spaced to allow the amount of water required to pass through the pipe wall, but inhibit the passage of fine material that would eventually fill up the well or cause damage to the pump.

To determine how much groundwater there was, a submersible pump was temporarily installed in the well that was capable of pumping more water than Cañafistol would require. The flow and change in water level over time (drawdown) were then recorded. The original intentention was to leave the pump running uninterrupted for 48 hours then measure the water level versus time after the pump is turned off as the aquifer recharges, or recuperates. However, the well drawdown reached a maximum of two feet after less than 30 minutes. The pump was stopped after eight hours since it was obvious that the strength of the aquifer was far greater than the demand of the proposed water system. The well recuperated to its original level in a matter of minutes.

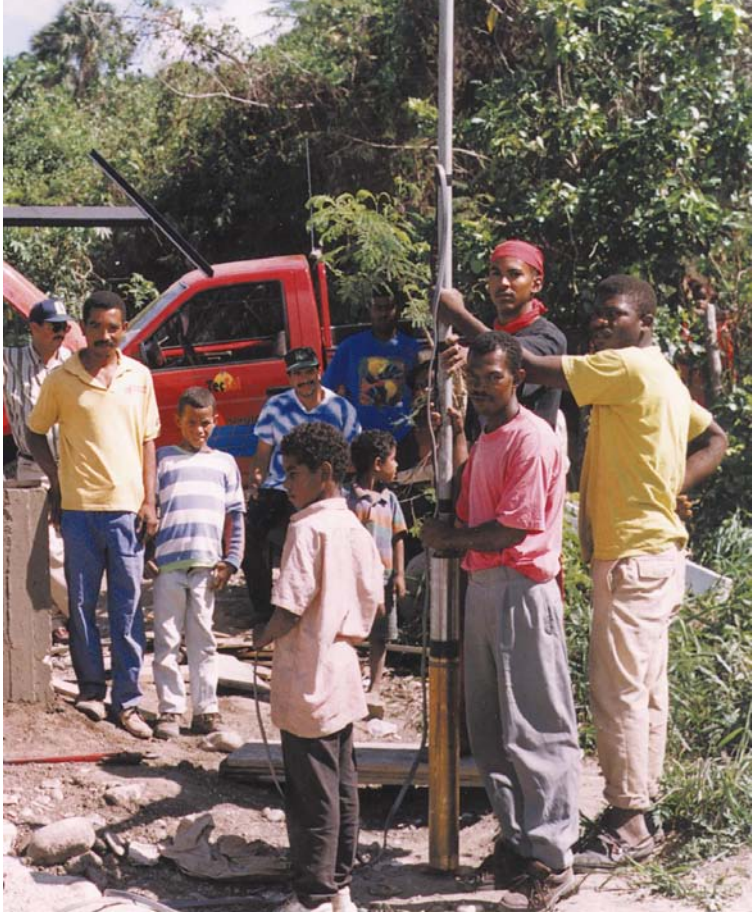
Water samples were taken before the end of the pumping test and left at the laboratory of the National Potable Water Institute (INAPA) in the capital city of Santo Domingo. One sample was for the physical/chemical analysis and the other for the bacteriological analysis. The results were all within the limits of industry standards for potable water.

Pumping Options

With a viable water source identified, the next obstacle was to determine the best method to lift the water to the tank site. The nearest electric lines are four miles away. Although the government-run electric company had expressed interest in extending the line, their resources were limited which all but eliminated the use of utility power as an option.

Also eliminated as an option was the use of a generator. The nearest gas station is 25 miles away and there are no vehicles in Cañafistol to transport fuel. Aside from the fuel problem and obvious impact on the local environment, a generator requires a certain level of maintenance that a community like Cañafistol may not be capable of providing.

Although the second well site yielded copious amounts of potable water, its location does not lend itself to wind power. The first site was better suited for wind, but didn't produce enough water. The technology of wind power is still an unknown factor in the Dominican Republic. INAPA has installed hundreds of windmill powered volumetric (piston) pumps around the country since the 60's, and few continue to function. To my knowledge there is only one rural water system that is using a wind turbine and submersible electric pump.



Above: The A.Y. McDonald pump assembled and ready for installation into the 35 foot deep well casing.

Furthermore, there are no local sales representatives for wind turbines. The development of wind power on the island has great potential, and the national meteorologic institute is in the process of compiling data for the public's use. The only drawback on wind power here is that sometimes there is a little too much wind in the form of tropical hurricanes.

Hydro was considered as a power source, but similar to wind, micro hydro can be very site specific. In addition, the lack of manufacturer's representatives in the Dominican Republic might require the direct import of parts to construct a micro hydro station. This practice is best avoided when working in rural development. If it can't be bought or built locally, don't use it.

That left PV panels as the best option. Thanks to non-profit grassroots organizations like Enersol of Somerville, MA, USA (see HP #34, pg.14), which have been promoting the use of PV powered rural electrification systems for over ten years, the technology of PV power is widely accepted in the Dominican Republic. That effort, combined with the country's electricity shortage, has lead to the creation of numerous PV system suppliers and installers.

Funding And Organization

CARE's proposal submitted to PRISA requesting funds for a PV powered water system for Cañafistol was quickly approved. PRISA agreed to fund the purchase

of all materials and tools required to build the system. CARE agreed to provide the designs, supervision, skilled labor, community organization, and training. The residents of Cañafistol signed a contract committing them to supplying any local building materials (rocks, sand, gravel, etc.), and all the community labor. Each homeowner was expected to contribute one day of work each week until the project's completion.

As part of CARE's obligation, the community was directed to form a water committee comprised of, and elected by, residents of Cañafistol. This group was responsible for organizing work brigades during the survey and construction phases. More importantly, they will act as the main governing body of the system after it is turned over to the community.

System Design

A compromise was made when trying to determine the amount of water the community would need. INAPA standards recommend a minimum of 40 gallons (150 liters) per person per day. The United Nations maintains that a person can survive with little more than 5 gallons (20 liters) per day. Most rural systems are designed using a per capita consumption between 13 and 26 gallons (50 to 100 liters) per day. We were limited by the PV direct pumps available here in the Dominican Republic and used 13 gallons per person per day.

A panel direct design does not have batteries and was proposed to avoid making the system too complex, expensive, and maintenance intensive. That left a limited number of pumps from which to choose. The most powerful pump available was the "Solar Sub" submersible pump manufactured by the A.Y. McDonald Mfg. Co. of Dubuque, IA, USA. It has a multi-stage centrifugal pump and a sealed, 90 Volt, permanent magnet, brushless DC motor.

Above: Clean drinking water is important for reducing the Domincan Republic's high child mortality rate.

Below: The TecSol crew giving the system a final test.

The total design head (TDH) takes into account factors such as elevation differences, well drawdown, and fiction losses in the pipe and fittings. Combing the TDH (128 feet) with the pump/motor efficiency (45%), maximum motor capacity (1,600 Watts), and amount of sunlight per day (6 hrs), the system would theoretically be able to pump around 10,500 gallons a day. Using a linear population growth of 2.5% per year over the project's 20 year design life will provide the future residents with 13 gallons (50 liters) of water per person per day. The donor felt that this was acceptable and the community members also felt satisfied with this amount. They estimated to be equivalent to the quantity of water they were hauling from the river daily for each family.

CARE wrote a brief specification of what was to be purchased and received bids from two suppliers. The winning bidder, TecSol of Santo Domingo, proposed using 43 Watt panels manufactured by Isofotón of Madrid, Spain. The panels were arranged in an array of five in series by seven in parallel with #10 wire to produce an open circuit voltage of almost 100 Volts DC. Both poles were switched and fused before leading to the pump. The panels and pump were all grounded.

The foundation and supporting structure for the panels were designed to withstand hurricane winds up to 250 km/hr (155 mph). In retrospect, this was excessive, since the high winds that a hurricane brings carry enough debris to destroy the panels long before the

Cañafistol Water Project Cost Summary

Item	*Cost*	*%*
PV Modules	$13,125	29%
Water Distribution System	$4,720	10%
Submersible Pump	$3,680	8%
Wells	$2,600	6%
Survey and Design	$2,100	5%
Water Storage Tank	$940	2%
Wiring, Boxes, Fuses, etc.	$850	2%
PV Module Site Protection	$710	2%
Tools	$700	2%
Forced Water Main	$685	1%
PV Module Mounts	$540	1%
Well Head and Pump Mount	$475	1%
Materials SubTotal	$31,125	68%
Training and Supervision	$7,500	16%
Community Participation	$4,875	11%
Skilled Labor	$2,500	5%
Labor Sub Total	$14,875	32%
Grand Total	$46,000	

structure is affected. The panel wiring has since been retrofitted to provide for easy emergency disconnects.

The forced main consists of almost 800 feet of 2 inch PVC pipe from the well to the storage tank site. Theoretically, it's almost unnecessary to provide any storage for a PV panel direct water system, since the pumping hours coincide well with the hours of consumption. However, it is recommended to have enough water stored for a few days when the sun doesn't shine. In this sense, Cañafistol's misfortune of never receiving much rain has been a blessing.

It was decided to build one 15,000 gallon tank out of stone and mortar, with the intention that the community members would build more if required. The distribution line has 1,800 feet of 3 inch PVC and 3,500 feet of 2 inch PVC pipe. The individual tap stands outside of each home are connected with 2 inch PVC pipe. The distribution system has one isolation valve and no pressure regulation. The maximum static pressure that the lowest house tap will see is 54 psi.

Sustainability

Cañafistol has an adult illiteracy rate that exceeds 80%. The two room houses typically have dirt floors and no windows. There is no electricity, a grammar school whose teacher can arrive only in good weather, no private or public vehicles, a bar, a billiard table, and a small store that sells only basic grains. The nearest clinic is six miles away on foot, and people too ill to walk are carried in a hammock hung from a long pole. Up to the end of 1995, there had never been a community project done there. Without proper organization and training, the chances of a community like Cañafistol being able to successfully manage and maintain a small municipal water system are remote.

A customary practice with rural water systems is to charge the home owner a set fee for the water they receive. Ideally, the users should pay for the amount of water they consume. However, due to cultural expectations and lack of interest, metered water is more the exception than the norm. The installation of individual water meters is a costly, maintenance-intensive option, and trying to determine the usage and cost of the water is often times a confusing and near impossible task. In the case of Cañafistol, CARE is recommending that each user pays enough to cover routine maintenance costs. In addition, the community is aware that they must save enough money to replace the pump at the end of its useful life. The panels and infrastructure are expected to last at least 20 years.

The longevity of the pump and motor is mainly dependant upon three factors: water quality, installation, and unit construction. After conversing with the pump manufacturer and taking into consideration the high quality of the water and the installation, we are estimating (hoping) that the unit will last eight years. This means that each user must contribute the equivalent of at least US$0.50 per month to the water committee in order to have the funds required to replace the pump. The community members have decided to start by paying $1.10 per month. After one year they plan to review regular maintenance costs and decide if they can afford to lower the fee. It's important to note that, although the fee may seem inexpensive, it is more than double what most communities pay that are serviced by INAPA.

The water committee will also receive the necessary training to administer the system. They have attended workshops in leadership, water system and latrine maintenance, and basic accounting. The committee members are appointed and elected at least once a year. They do not receive any payments for their efforts, other than the satisfaction of knowing that they are the key elements involved in providing a healthier lifestyle for their community.

The total cost of the materials for the water system came to approximately $31,125, which calculates out to under $57 per person. This value is below the average

of $60 to $100 per person that most systems cost. Taking into account community participation, skilled labor, and training, the cost per person is around $85 per person. Another way of looking at it is to say that when the system reaches the end of its design life, each 43 Watt PV panel will be working to provide clean drinking water for almost four houses.

Conclusion

At this writing, the system has performed within design expectations. On a clear day in July, the pump starts slowly around 8 AM and runs continuously until 4 PM, providing over 12,000 gallons of potable water. The rare cloudy day will lower the yield to around 7,000 gallons.

This project provides the infrastructure necessary to help break the most common disease cycle afflicting less developed nations. Another bonus is the community members' pride in their water system. They helped design it, build it, and now they own and maintain it. Firmly convinced in the power of the PV panel, many home owners are considering purchasing small battery charging systems to power a few lights and possibly a radio or small TV.

In a country that counts Major League Baseball players as one of its main exports, access to clean water and sanitation plays an ever increasing role in the field of child survival. The fact that this goal can be achieved using sustainable renewable energy is a welcome benefit. I wonder what Columbus would think now?

Access

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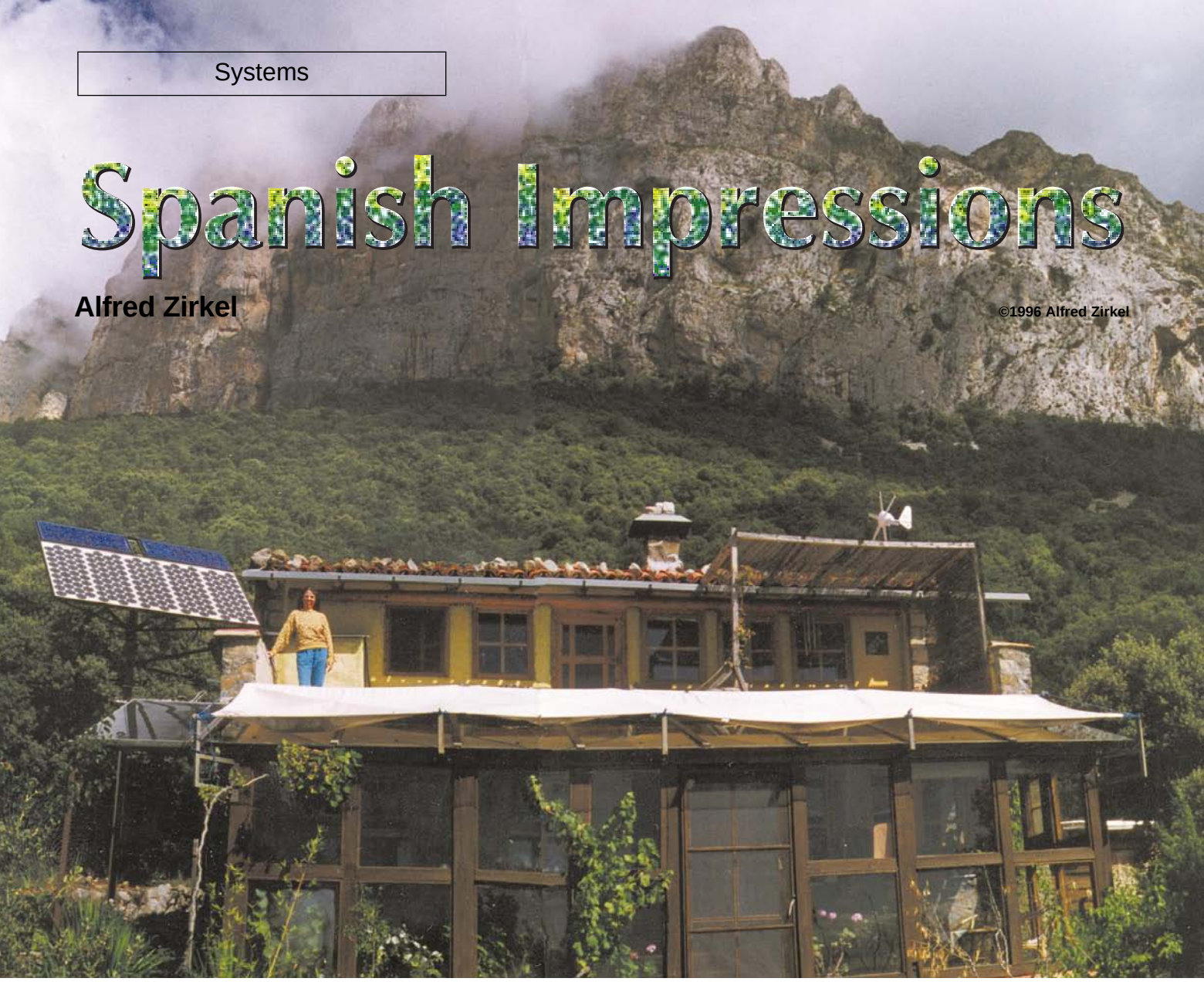
Spanish Impressions

Alfred Zirkel



Petra's and my life together began at the Arya Tara Institute in Germany, a Tibetan center. We both lived there for about four years. Then we wished to do something on our own. We decided to say goodbye to Germany and settle in Spain. It is a lot less populated and we were attracted by the fact that, at that time, the lifestyle was simpler.

We bought a Land Rover, loaded it up, and started out without a fixed destination. All we had was the address of a friend. In Germany we heard that it was very easy to buy land in the central part of the Spanish Pyrenees. This turned out to be a fantasy. Our savings amounted to $25,000, so we couldn't afford to pay much for a piece of land. And we had only started to learn Spanish.

A year's worth of intense search for suitable land was in vain. We had spent half of our savings, but did find jobs and finally a piece of land. In more ways than one, this land was in harmony with the Chinese philosophy of Feng Shui—mountains in the north rising to a height of 7,000 feet and a spring nearby. Towards the south, more unobstructed views over flat hills. Spain is about 20% larger than California and has 280 to 300 sunny days per year in most parts of the country. Unfortunately and absurdly, people still spend a lot of money to get connected to the electric power grid. This happens especially in the countryside and even in abandoned villages.

A Solar House

Petra went back into her profession as an architect with a focus on solar architecture. We designed a 2 story, 30 by 30 foot house. Upstairs on the south side is a large

terrace. Facing north is a bedroom and a storage space. On the first floor is the kitchen, guestroom, and toolshop. It took us one year to build, using the traditional style with stone, wood, and local materials. We built everything ourselves, including the electrical system and the plumbing. Now we can help others with this treasure of experiences.

Energy Production

From the beginning we knew that we wanted a photovoltaic system. Our first one consisted of Conrad Electronic amorphous 12 Watt modules (Germany) and two car batteries with a small regulator, for lighting. After two years we enlarged the system with two 60 Watt Helios modules (Italy), and installed two new 160 Ampere-hour batteries The regulator at that time was a Spanish 15 Ampere model.

Above: An 80 Watt Rutland converts the turbulant Pyrenees winds to additional power during periods with little sun.

Obviously, it was and still is a very simple system, but it works. In 1993, we added a 9 by 27 foot greenhouse to the south facade. During the cold season (from October to April) the greenhouse provides heat for most of the house. In summer we cover the glass roof. This prevents the sun from heating up the facade keeping the house cooler. The main heater is a self-made stone stove in the center of the house. It burns wood only. It also heats water for the showers and kitchen in a 300 liter boiler. On sunny days the 300 liters are heated up by the 6 by 3 foot warm water collector. Every day during the summer we get 300 liters of very hot water. Both of the warm water systems work without a pump, since the storage container is at the highest point. All of the pipes are 1/2 inch copper.

Below: A 9 foot by 27 foot add-on greenhouse provides much of the heat for the Zirkel's Spanish mountainside home.

All of the walls of the house have a horizontal moisture barrier about 1 foot above ground to prevent water from seeping up the walls. On the ground level, most floors have a six inch air space for thermal insulation. During the warm season (from April to October) we use liquid gas for cooking, as do most Spanish households. This costs us about $5 for three months. During winter we use the wood-burning stove for cooking. It is located in the center of the house. With three cases of wood we can heat the entire house, cook our food, and get 200 liters of hot water.

Above: Alfred Zirkel next to the PV panels that keep him happily off-grid.

Bio-Architecture

In 1993, Petra started working as a bio-architect. We don't use any kind of suspect materials like fiberglass insulation, non-natural colors for house and wood painting, PVC plastics, or similar components. Only 6% of the building materials here are tested for possible health effects. So we don't know exactly how they effect the body and mind, especially if we spend many hours each winter day in a closed room. Most of our work is in designing stand-alone, single family houses. So it's easy to keep a north-south orientation to use the sun for heating.

PV-Renovation

When we purchased a personal computer we again remodeled and enlarged our solar electric system. It now consists of five Helios (Italy) and two Solarex 60 Watt modules mounted on a 12 foot rotatable tower. The modules are permanently mounted at an angle of 45 degrees. The regulator is a 25 Ampere Siemens. The six batteries are Italian 2 Volt, 960 Ampere-hour cells. A 300 Watt Conrad Electronic sine wave inverter provides power for the computer. For lighting we use fourteen 11 Watt, 12 Volt economy bulbs.

For winter backup we installed a 500 Watt Windseeker, which worked no more than 20 times a year. Since the air here is very turbulent, most of the time the Windseeker "didn't know where to turn." So we removed it and mounted an 80 Watt Rutland instead. It works more often and provides more power than the Windseeker.

On cloudy days when we need additional power for the computer, we run the generator. Our 220 vac, 1500 watt gasoline engine was much too noisy, so I remodeled an old 2 hp Citroen engine and connected it to a 500 Watt, Ford Fiesta 12 Volt DC generator. The engine was set up about 40 feet from the house and the original Ford Fiesta regulator was mounted at the battery to avoid losses. The regulator measures the voltage directly at the battery and the generator then produces about 17 to 18 Volts DC to compensate for losses in the line. The wire from the engine to the battery is 10 mm thick. Two years ago the Citroen gasoline engine was replaced by a one cylinder diesel rototiller engine. We kept the generator and regulator. Fuel consumption is at most 1/2 liter of diesel fuel per hour.

Water Politics

Our drinking water comes from a mountain spring and is piped directly to the house through 2,100 feet of 1/2 inch pipe. The spring produces 500,000 liters daily, of which 150,000 liters pass by our house at a distance of 600 feet. The complicated regulations established by our neighbors for the use of the water prevents us from using this source to produce power. We were recently offered connection to the power service line (1,800 feet) almost for free, but we declined the offer.

Right: A diesel rototiller engine with the car alternator.

Realize your Dreams

Our Buddhist teachers stress time and again that we alone are responsible for our acts—nobody else. We would like to advise all those now starting out to never lose faith in the sun, the wind, the water, or in themselves, to carry out their dreams.

Access

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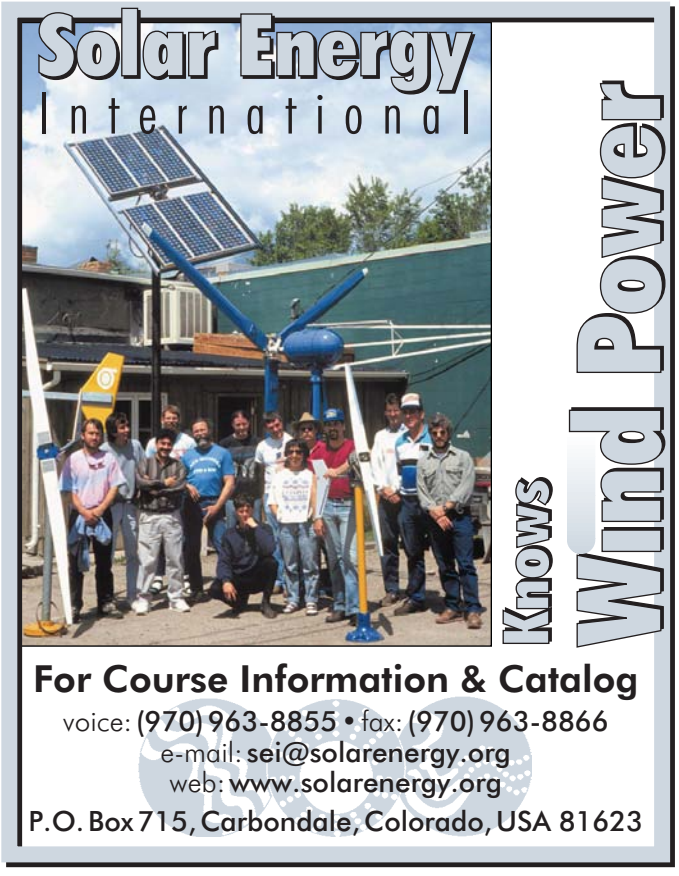

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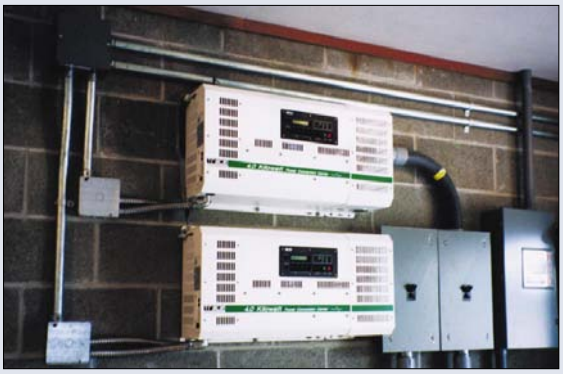

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A Kid Hooked On Wind Power

Corey Babcock

It began with my love of fans when I was very young. From there it went to watching an Aeromotor windmill pump water. My interest in wind power skyrocketed when I saw an article in a children's newspaper when I was about ten or so. The newspaper said that in order to get more information on wind power, contact the American Wind Energy Association (AWEA). So I did, and I received loads of information from them. I got really excited about wind power when I saw a picture of a turbine from the Tehachapi Pass windfarm in California, and it went on from there.

Getting Information

My first step in wind power was getting information. AWEA is the nation's most knowledgeable resource on wind power. They can give you figures for what the average wind speed is in your area. They are most informative about windfarm-sized equipment, though. They also have a publications list to order other helpful items. I received info on major wind developers and their addresses. I contacted a few of them to see what information they had to offer. I now have a file cabinet which is so full that if you open one of the drawers without holding on to it, the whole cabinet will fall over! It takes years to get that much stuff. I have contacted companies from Australia to New Zealand in search of more information. After reading all this information, I wanted to have a wind system of my own! I would always imagine a huge windfarm-sized machine turning in my backyard. Life is built on dreams, I guess.

Left: Corey descends to safety as "Patriot" winds up.

Right: Newly painted blades ready for mounting.

My First Wind System

In 1990, I built what you could call my first lawn ornament—a wind turbine made out of some junk that was laying around. The wind machine was an upwind type with a three bladed, side-facing rotor. The generator was a car alternator and it took nearly a gale wind to make any usable electricity. I think the reason for this is that the blades were made of plywood and were only 3.5 feet in diameter. Being ten years old at the time and having no idea what an airfoil was or how to make one, I just used what was lying around. The plywood blades created what I like to call a "flat-attack" because they are absolutely flat with no shape to them. I took the alternator's cooling fan off and flattened out three of the fan blades at 120 degree intervals. The flattened fan blades were then twisted to give the blades pitch when they were bolted on. Now you see why it took nearly a gale to produce usable power!

I made the tail out of the same 1/8 inch plywood as the blades. The tail boom was made of 1/2 inch electrical conduit that was bent to allow for the tail and to bolt onto the hinge. The tail was kept behind the blades by a spring and could be folded by with a lever at the tower's base.

The turntable assembly was rather simple, merely a sleeve. I took a piece of 2 1/2 inch water pipe and put a cap on top. I drilled a hole in the cap for the wires from the alternator. The water pipe slipped over the stub mast on top of the tower and the cap held the pipe up. I also placed a roller bearing between the tower top and the cap. The wires from the alternator went through the hole and down the tower.

The machine's control was literally a light switch. The machine was either on or off. I left the rest of it to the regulator. I figured that the regulator did its job when it was charging a car's battery, so why not now? I used an old, lead-acid lawn mower battery. The system powered a few 12 Volt lights and a small homemade ceiling fan. I loved being able to tell my mom not to worry if I forgot to turn off my ceiling fan!

For a tower, I started with a small tripod and made a 12 foot tall angle iron mast with guy wires. The tower was somewhat self supporting, but had no concrete footings. I added a couple of guy wires so it wouldn't fall over when it was wet out. The machine was taken down in 1994 so I could use the tower for my next project. To tell you the truth I don't miss it!

My 30 Foot Tower

I put the 12 foot tower on top of a 20 foot section of a windmill tower. After all the bolting and welding was finished, I had nearly a thirty foot tower, but still way too short for my site. I am 15 years old and I haven't had a real job yet so I'll use what I have. I bolted a trailer winch onto the tower to be able to shut the machine off. It works like a charm.

Above: Author Corey and his most recent all home-built wind generator.

Now that I've got a tower, what's next? Another home-built wind generator, of course!

Phase Two

Someone should have slapped me upside the head when I made this one! Once again I used "flat-attack" type blades. Instead of an alternator, I used a permanent magnet motor. The motor, when spun, works as a generator. I was making progress. This machine also was an upwind type and had a four foot, three bladed, side facing rotor. The turbine was capable of charging up a few flashlight batteries in a breeze and a 6 Volt motorcycle battery in a good 15 mph wind.

I used fan blade holders for a blade hub. I got a set of metal blades like the ones from a box fan or an air conditioner (available at any Fleet Farm store). I drilled out the rivets holding the sheet metal pieces on. What was left was three blade holders with a hub and set screws. The hub slipped over the generator shaft and was tightened down with the set screws. The plywood blades were bolted onto the fan blade holders.

For a tail boom I used 1/2 inch electrical conduit. The tail was made of plywood also. The tail assembly was bolted onto a hinge so I could shut the machine down and so that it could side-face in high winds. The hinge was welded onto the sleeve assembly. A spring was used to keep the tail behind the blades under normal conditions. The spring could be adjusted to regulate the speed at which the wind machine would begin to furl.

Left: Corey's bedroom displays a fully restored Zenith Radio Wincharger along with a copy of the original operator's manual.

I tried to make a slip ring assembly for it too, but it didn't last long. I took a 2 by 4 and cut out a "doughnut." I put some flattened copper pipe around the outside. It slipped onto the pipe of the tower. I made a brush out of an old wiper arm. The brush rubbed on the flattened copper pipe as the plant turned. After a few weeks of operation the doughnut split and broke. I figured that it would be easier to use some #10 fine stranded insulated wire run from the generator down through the tower pipe. The wire will resist the twisting action for a long time.

Making Progress

Last winter I adapted a set of six foot blades to the machine. The turbine got a longer tail arm and a larger tail vane. These blades were actually airfoil type! After I installed those blades I kept asking where all the power was coming from. The blades were bolted onto those fan blade holders from before. That's the whole reason that they aren't still being used. The set screws on the hub let loose and the blades took off. Literally! The assembly landed about 150 feet from the tower. Only one of the three blades was salvageable.

Last spring I made some new blades. This usually takes about a month or so, but I had them laid out, cut out, tapered, and rasped to give pitch in about a week. I think that I finished them so fast because they were made of straight-grained pine. I used pine because it is soft and easy to carve. It took another day or two to dynamically balance the blades. I did that by hooking 24 Volts to the generator and motoring it with the blades attached. I simply placed a movable weight on the blades that needed to be balanced. After I found the right spot I attached little three or five gram weights according to how much was needed.

The next step was to track the blades. The blades that were closer to the stub tower needed to have shims put between the blades and the holders. The shims can be small pieces of wood, pieces of sheet metal, or even a penny works well.

The blades made this spring were blown to pieces because the pin, which keeps the tail from going into the blades when they side-face, sheered off. It was a windy spring day when the accident happened. It just goes to show, make sure that every little thing is operational before you let the system fly on its own.

I made the controls from readily available Radio Shack parts. I purchased a relay, diodes, and all the necessary fuses. The toggle switches were rather outrageously priced so I bought them elsewhere. I put a diode in the main generating circuit. I figured that I would use a diode instead of an electro-magnetic cutout relay. I use the relay that I purchased as a vibrating voltage regulator.

Zenith Radio Wincharger

The "Zenith," as I like to call it, is a wind turbine that was made by the Wincharger Corporation in the early thirties. It is a small 6 Volt machine used to charge the batteries for a farm radio. An article telling the story appeared in HP #27. It has an upwind, six foot rotor and is controlled by the "poorman's" air brake. I got it in the spring of 1993. My uncle, Larry Mundt, gave it to me for free. He almost forgot that it was out on the junk pile until I found it. When I got the Zenith it was nothing more than a pile of rusty scrap iron. I was amazed when I read the faint letters on the tail for the fist time. At the time I couldn't imagine that anyone would just throw something like this out. But I learned how the REA (Rural Electrification Act) made farmers take their wind machines down before they could get the new utility power. Some liked their wind machines and didn't want the utility, but most gave in. It is truly a sad story!

The Zenith took about three to four months of work before I had it up and running. The part that took the most time was the propeller. The first propeller was made from some plans in the 1945 edition of the LeJay Manual. The plans were well laid out and to the point. They even showed how to give the blades "twist". The prop's center was about an inch and a half thick. The tips, however, were only about a quarter of an inch thick. To give the prop that taper I used a jig saw with a really long rough-cutting blade. Don't try that in heavy wood like I did; you'll burn out your jig saw and have to finish by hand. I learned the hard way!

To give the propeller its pitch, I needed to do a lot of work with a wood rasp. It took me about four weeks to make a seven foot propeller. When I made the propeller, I only did half of the carving required. I carved the face of the blade to have a sharp trailing edge and that was it! I never rounded off the leading edge. The blades would have needed a generator that had a cut-in speed of about 40 rpm! The blades would turn in the lightest winds but they went way too slow. I quickly realized that something was wrong. After I read the fine print on the plans a few times I found the phrase: "Leading edge sharp…." A light bulb instantly turned on and with a few days worth of rasping, the prop was the fastest thing I had ever seen.

I used a simple cut-out relay for controls with the Zenith. The original control panel wasn't really anything more than that except that it had a two direction ammeter.

At first I didn't know that the Zenith used an air brake governor. I didn't even know what one was or what it looked like until I received a copy of a Wincharger pamphlet from Lake Michigan Wind & Sun. I figured I needed one because I was getting about 13 to 14 Volts DC from a 6 Volt generator! I still can't believe that the generator wasn't ruined from being used like that for about a half year. I guess this was because the wind machine was only on its five foot tower, and you don't get the greatest winds at that height.

The Zenith was put on display in my new bedroom last fall. I decided to show the machine instead of using it. Mick Sagrillo of LMW&S photo-copied the Wincharger pamphlet that was sent out to rural areas in the thirties. Thanks again Mick! It goes great with the Zenith!

Another Pre-REA

In January, I decided to start working on my uncle Larry's Winpower. It is a large direct drive wind machine from the thirties. The Winpower was used to charge 32 Volt batteries. The batteries then powered lights in the barn. The system had a back up Westinghouse/Delco generator. I am in the process of retrieving that now.

During the cold winter months I worked on the blades. They were in great condition for being sixty years old. The person who took them down had enough sense to store them in the rafters of the garage. They sat there for nearly sixty years! Over the years the blades collected a lot of dust and grime. That all needed to be taken off. I started by cleaning the copper on the leading edges to a brilliant shine. I could have removed the copper, but I want to keep the plant as original looking as possible. The next step was sanding the blades smooth. To do this I used 60 grit sand paper on my parents' belt sander. Then I progressed my way down for a smooth finish.

After all the blades were smooth, I needed to protect them from the elements. Before any painting was done, I gave all three blades a good soaking of Thompson's Water Seal. This will help protect the blades even more. Next I put five coats of paint on each side of the blade. The paint that I used was the kind used on boats. If I could do this over, I wouldn't paint the blades. I would use water seal and then put about eight coats of clear finish on them. Then the blades would have the original wood finish.

I feel that climbing the tower is the best part! It's fun because once you're up fifty feet, you can see so far around. It's unbelievable. It's really too bad that not much work can be done on top of the tower. All the work that needs to be done on this machine deals with very heavy components. The brake band needs replacing and the only way to do that is to take the generator apart. I would like to see someone do that one fifty feet up! If there is anybody out there that is fairly close to southeastern Minnesota and has the hardware to take a machine down, we are looking to do it at a fairly low price. A crane is outright over-priced. The farm has many tractors and such to help with the lowering.

More Tower Fun and a Vacation

Recently my family and I erected a forty-five foot tower that my uncle Roger gave me. It is pretty much an antenna tower, and I haven't got anything on top yet, but my anemometer should be up there pretty quick! This year we are finally getting out to California, one of my long awaited dreams. We are going out there to visit the Altamont Pass windfarm and see the ocean! I can't wait! Hey, dreams do come true!

Access

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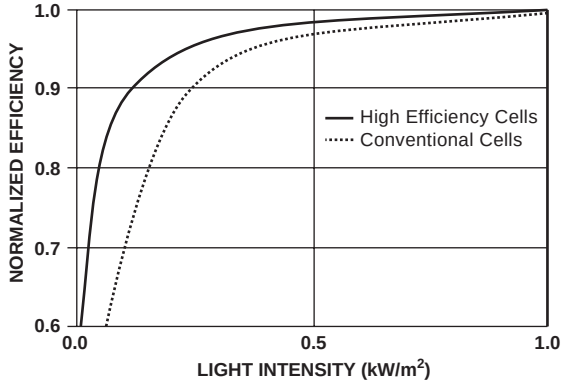

Technical Specifications

Module Catalog Number	BP590F
Nominal Peak Power (Pmax)	90.00W
Voltage @ maximum power (Vmp)	18.50V
Current @ maximum power (Imp)	4.86A
Open-circuit Voltage (Voc)	22.30V
Short-circuit current (Isc)	5.20A
Coefficient of Voltage	-0.079V/°C
Minimum Power	85W

Dimensions

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Tilt Up-Grade (T.U.G.)

Matt Danning

If the loyal readers of *Home Power Magazine* can stomach another article on tilt-up towers, I'd like to relate my experience working with Enersol Associates, the premier purveyor of rural-based solar electrification in the Caribbean.

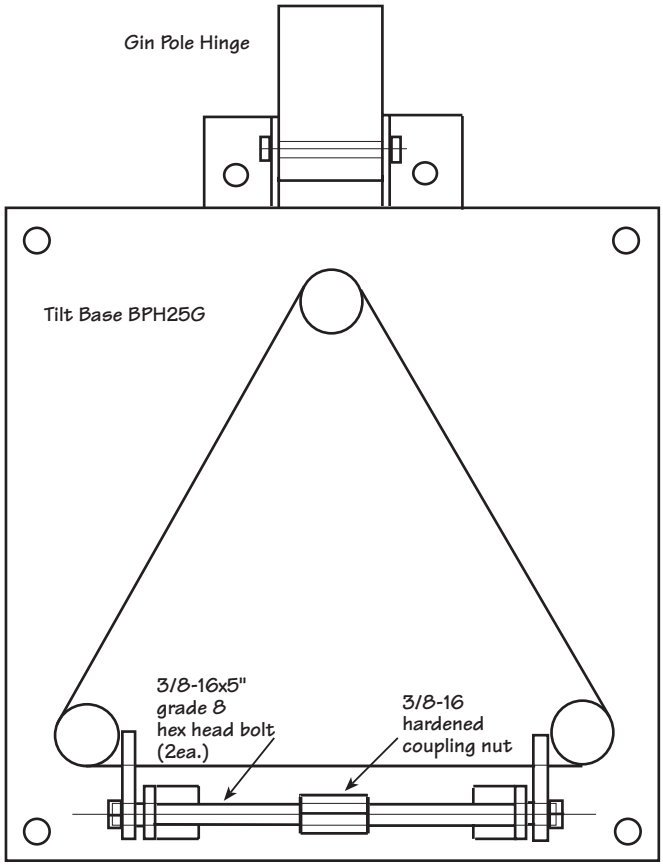
In March of 1994, I had the opportunity to travel to the northern coast of the Dominican Republic to erect a Bergey 1.5 kW wind turbine for pumping water. One priority was to use local labor in all aspects of the construction. In addition, to minimize costs, we decided to utilize only "appropriate technology", i.e. no electricity or heavy equipment. Bergey supplies a Rohn 25G communications tower, various adapters, and hardware to mount the turbine. Bergey recommends erecting the tower in stages, then lifting the turbine minus blades using a top-mounted gin pole. Blade attachment and electrical hook-up is then completed up-tower. Because of the inherent risks in working 60 feet above ground, we decided to complete the construction and electrical work on the ground, then tilt the tower and turbine into place using a hinged tower base and gin pole.

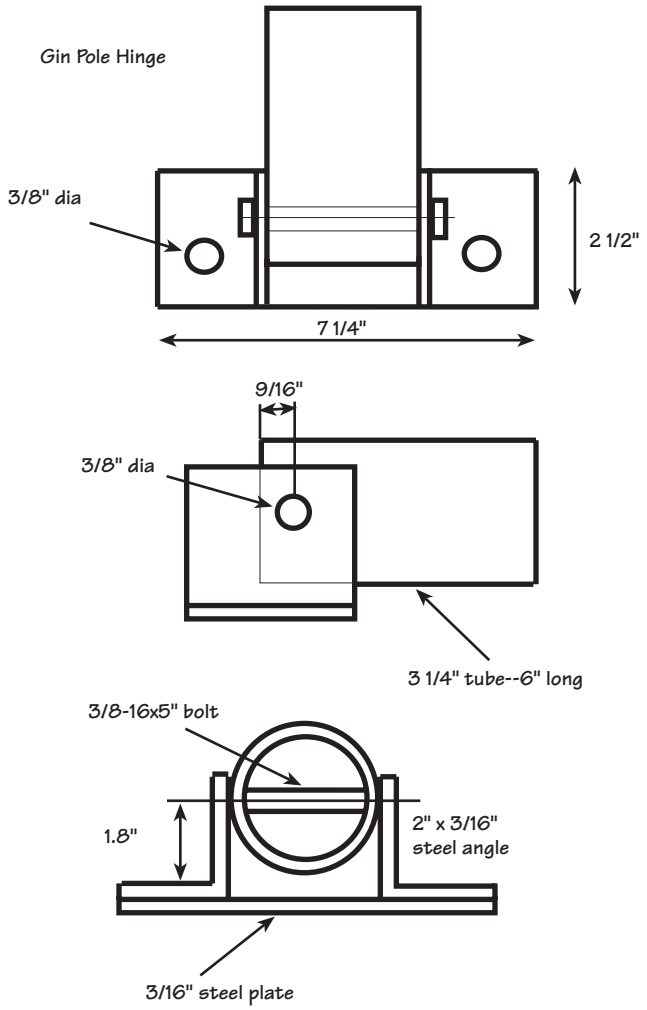
This article shows you how to strengthen a standard Rohn BPH25G tilt base, how to build a gin pole, what hardware and parts you will need, and what techniques will ease the lift. Note that the sizing of components and hardware is based on calculations for a 60 foot tower, and that loads would be significantly greater if a taller tower were used. The information in this article should not be used for a taller tower or a heavier wind turbine without the input of a mechanical or structural engineer.

The BPH is designed for tipping up no more than one section of Rohn 25G tower. By modifying the hinge we used it to tip up 60 feet of tower with our Bergey perched atop. We first replaced the short 3/8 inch bolts with two 5 inch, grade 8 bolts. We joined them with a hardened coupling nut (available at machinist's supply houses) to form one long hinge pin.

For our gin pole, we used common 2 1/2 inch Schedule 40 irrigation pipe. I calculated the buckling load on our gin pole to be a maximum of 890 lbs. I then calculated the critical buckling load (Pcrit) of several pipe sizes at a length of 30 feet. For 2 inch Schedule 40 pipe, Pcrit is 1500 lbs. For 2 inch Schedule 80 pipe it is 1948 lbs., and for 2 1/2 inch Schedule 40 pipe Pcrit is 3380 lbs. Because these calculations are based on a perfectly straight column, and because Schedule 80 pipe was not as readily available in the Dominican Republic, I chose to be conservative and use the heavier size. In fact, even the heavy pipe looks pretty spindly at 30 feet, especially when $5000 worth of equipment is depending upon its integrity.

For the pole we purchased three 10 foot lengths of pipe, and two 1 1/2 foot lengths of steel tube with an outside diameter of 3 1/4 inch and a wall thickness of 3/16 inch. It is a peculiarity of pipe that its size does not refer to its true diameter. For instance, 2 1/2 inch Schedule 40 pipe is actually 2.875 inches in diameter. Because the tube's inside diameter matched the pipe's outside diameter we could use the tube as a coupling





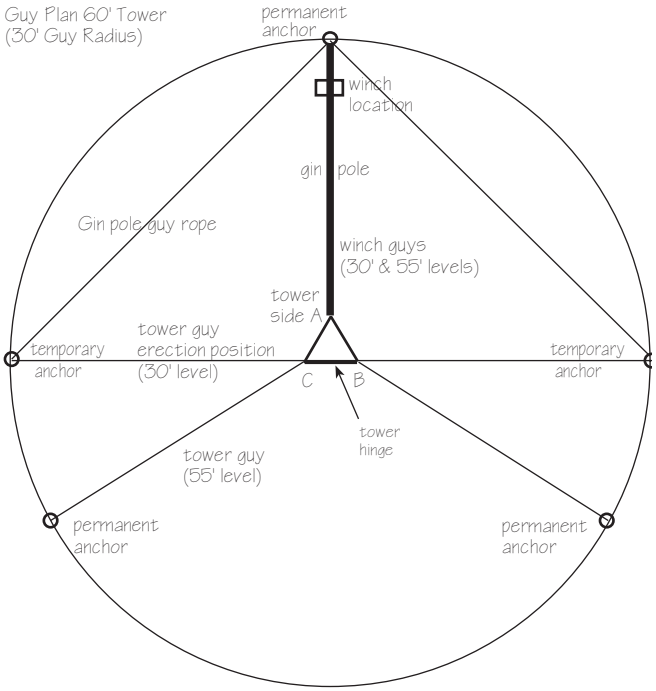
sleeve to join the pieces of pipe. We had to do a bit of filing and shimming to make the parts fit snugly, but I think that was due to the relatively loose tolerances of the Dominican-manufactured pipe. To keep the sleeve from sliding when the pole was erect, we attached hose clamps around the pipe at the base of the couplings.

For the gin pole hinge we used a 6 inches of the 3 1/4 inch tubing, two pieces of 2 inch angle iron 3/16 inch thick welded to a 3/16 inch steel plate, and a 3/8-16 by 4 1/2 inch grade 5 hex head bolt and nut for the hinge pin itself. The drawing shows the general configuration and critical dimensions. The hinge assembly is bolted to the concrete tower foundation with 3/8 inch concrete anchor bolts which are installed when the foundation was poured. The tower foundation needs to be made 2 1/2 inch wider to accommodate the hinge assembly.

The top of the gin pole has four attachment points. At the first point the winch cable or rope is attached. Opposite that point, the guy cables from one side of the tower are attached. These cables will be pulling the turbine up as the gin pole winches down. The side attachment points are used to stabilize the gin pole side to side as the tower and turbine are pulled up. To attach the winch cable and the guy cables, we used 1/2-13 by 1 1/2 inch shouldered eyebolts and nuts. These are drop-forged eyes used specifically for lifting, and are rated at 2400 lbs. We simply drilled two diametrically opposite 1/2 inch holes 1 1/2 inch from the top of the pole. For the side stabilizers, we tied one end of 1/2 inch truck rope to the winch eye.

When tilting up a tower, it is normal to use four guy stations to stabilize the tower perpendicular to the hinge. Because our site had periods of calm, we were able to use a hybrid method, saving the cost of a fourth set of guy cables. The diagram below shows the tower in its “hybrid” configuration just after it was lifted. The winch is located just ahead of the permanent anchors. Prior to the lift, the tower, gin pole, and cables should be in the following positions: The tower is lying down with the gin pole standing up. The gin pole’s side guy ropes are attached to the temporary anchors. Both guy cables on tower side A are attached to the top of the gin pole. The winch cable is attached opposite the side A guy cables. The B and C guy cables at the 30 foot level are attached to the temporary anchors to give the tower stability side to side as it’s being lifted. The B and C guy cables at the 55 foot level are attached to their permanent anchors to keep the tower from toppling over after it is fully erect.

Proceed with the lift as follows: Pull steadily on the winch cable (we actually used a rope, block and tackle, and five people to pull the tower up by hand). Meanwhile, make sure the gin pole remains in line with



Parts and Materials List

Item	*Quantity*
1/2-13 x 1 1/2 inch lifting eye bolt McMaster-Carr # 3014T491	2
1/2-13 grade 8 nut	2
1/2-13 grade 8 washer	2
1/2-13 grade 8 lock washer	2
3/8 inch concrete anchor bolt McMaster-Carr # 91587A120	2
3/8-16 galvanized nut	2
3/8 inch galvanized flat washer	2
1/2 inch concrete anchor bolt McMaster-Carr # 91587A220	4
3/8-16 galvanized nut	4
3/8 inch galvanized flat washer	4
3/8-16 x 5 inch grade 8 hex head bolt McMaster-Carr # 91257A644	3
3/8-16 grade 2 nut	1
3/8-16 coupling nut McMaster-Carr # 90977A031	1
Temporary anchor McMaster-Carr # 3718T4	2
Load rated spring snap with 1 inch opening McMaster-Carr # 3933T19	2
3 1/4 inch seamless steel tubing 3/16 inch wall thickness	42 inches
2 inch x 3/16 inch angle iron	6 inches
3/16 inch steel plate	3 x 8 inches
1/2 inch Truck rope	100 feet

the winch cable, and that the tower also remains straight. When the tower is fully erect, disconnect the A side 55 foot guy cable from the gin pole and attach it to the permanent anchor. Next, disconnect the A side 30 foot guy cable from the gin pole and attach it to the permanent anchor. Then, one at a time, disconnect the B and C side 30 foot guy cables from the temporary anchors and attach them to their permanent anchors. Finally, tighten the guy cable turnbuckles according to Bergey's instructions. The gin pole may now be removed.

Access

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COMM.POWER

Back Country Radio

Richard Perez

I'm a radio junky. I built my first shortwave radio receiver in 1957 at the age of 12. I was instantly hooked on the magic of radio and remain firmly addicted to this day. When it comes to wireless communication over a distance, radio is the only way.

When Karen and I moved to Agate Flat in 1970, we went into deep information withdrawal. We had no radio, no TV, no telephone, and only saw a newspaper a few times each year when we went to town. For a period of about four years, we remained in an information vacuum—we were aware of happenings only at our immediate homestead. This suited the inward direction of our attention—all the news we needed then was located inside….

Early in 1975, a neighbor loaned us his battery-powered shortwave radio. After years of ignoring the world, we had the BBC, Radio Moscow, and all the local news right in our face. We were amazed, frightened, and delighted all in the space of an hour. We learned the war in Vietnam was finally coming to an end. We learned that Nixon was not a crook. We learned about tomorrow's weather—at home and in Kathmandu.

We humans are indeed social animals. We need to communicate. We need to know about the happenings of our neighbors and fellow planetary inhabitants. We need to talk with our families. We need to conduct businesses requiring communications even if we are located miles from the nearest telephone wire. My attitude is: if we can make our own electricity miles from the grid, then we should jolly well be able to provide all the communications we want. It's easy and fun—just add radio!

Let's look at some basic facts and characteristics of radio. If you understand these concepts, then it's easy to equip your homestead with whatever forms of radio communication you may wish.

Radio Waves

Radio is just a special name for a type of alternating current electricity. If you are fuzzy on the concepts of alternating current, then read my basic electric articles in HP#52 and HP#53. The only real difference between the alternating current coming out your wall power socket and radio is frequency. Frequency is the number of cycles that the current changes polarity per second. Each cycle per second is called a Hertz (abbreviated as Hz) after Heinrich Hertz who originated the concept in the 1880s. The alternating current we use for electric power has a frequency of either 60 Hz (or 60 cycles per second) if we live in the USA and other countries, or 50 Hz (50 cycles per second) if we live in Europe and in many other places.

Radio uses much higher frequencies, from around 1,000,000 Hz (or using radio lingo 1 MHz) for broadcast AM radio to over 10,000,000,000 Hz (10 GHz) for microwave communications. Most radio communications currently use frequencies between 0.5 MHz and 1,000 MHz. Within this spectrum falls AM broadcast, all short wave bands, Citizen Band (CB) radio, television broadcasting, FM stereo broadcasting, police/fire/military radios, and cellular telephones.

An interesting fact of physics is that alternating current generates an electromagnetic field which can travel (or in radio lingo, propagate), sans wire, through space. This Radio Frequency (RF) field is the basis of all radio communications. It propagates throughout the Universe (that's right, our radio broadcasts will reach the star Alpha Centauri in about four years), as well as all over our planet.

The Radio Spectrum

On page 44 and 45 is a graphic that shows the current RF spectrum used for communications. The horizontal axis of the graph is the frequency of the radio signal in MegaHertz (MHz). If the information on this graph seems tightly organized, that is because it is. Imagine what would happen if all radio transmissions were located at the same frequency—total chaos. This is why the radio frequency spectrum is tightly divided and regulated by international agreement.

Frequency and Propagation

Different frequencies of radio propagate differently. Radio between 0.5 MHz and about 30 MHz have the capability of traveling all over the globe. The radio waves are either bent along the earth's curvature, or reflected from ionized layers in the atmosphere. Low

frequency radio easily propagates over mountains and through obstacles. Consider AM broadcast radio—during the day you can easily hear stations within several hundred miles and at night you can receive stations from all over the country.

In the portion of the radio spectrum between 3 MHz and 30 MHz, we find the shortwave bands. Here broadcast stations from all over the world can be received. In this region are also several ham radio bands which provide global two-way communication for amateur radio operators. The Citizens Band two-way radios operate around 27 MHz at the top of the shortwave bands. All the shortwave bands share the ability to "skip" or be reflected by ionized layers in the earth's upper atmosphere. When the radio signal is reflected back to earth it may fall thousands of miles from the original transmitter. This can be both a blessing and a curse. I have talked to hams in Australia while using only four watts of transmitter power. I've also seen the CB radio so clogged with nationwide skip as to be useless.

One of the most interesting bands for communications is the area between 50 MHz and 200 MHz. Here the frequency is not so high as to limit communications to strictly line of sight, but high enough to make reflected waves or "skip" a rarity. In this area of the spectrum resides VHF broadcast television, FM stereo broadcast, a very useful ham radio band at 144 MHz, several types of radiotelephone service, and police/fire communications.

As the frequency of the radio wave increases, its propagation becomes more "line of sight", just like a beam of light. At over 400 MHz, the radio signals begin to restrict radio communication to a direct, unobstructed path. Services using the over 400 MHz, ultra high frequency (UHF) bands are UHF broadcast TV, several ham bands, radiotelephone services, cellular telephone, and police/fire. Due to the line of sight nature of these UHF bands, most services use repeaters. Repeaters are special radios, strategically located to rebroadcast signals for longer distances and around obstacles.

Types of Modulation

There are two common ways of placing information on radio waves (a process known as modulation). The oldest method is known as amplitude modulation or AM. Here the radio waves have their voltage (amplitude) modified, or modulated, to carry the information. The second type of commonly used modulation is frequency modulation or FM. FM radio encodes the information on the radio waves by varying the frequency of the radio waves. The distinction between the two types of modulation is important because all natural and most human-made radio frequency (RF) noise is amplitude modulated. This means that AM radios are much more susceptible to interference from RF noise than FM radios.

Antennas and Feedlines

No matter what type of radio you use, it will have an antenna. An antenna is a large, metallic object engineered to intercept (and broadcast) radio waves. When it comes to antennas, bigger and higher are always better. Even the most expensive radio or TV equipment won't work well without a good antenna. Think of the antenna as your "net" for catching radio waves. A bigger antenna means more area to capture or radiate radio waves. Bigger antennas will receive (hear) and transmit (talk) further distances. Radio signals are like the wind in one way—the higher you get, the more intense they get. Even the biggest antenna won't work well in the basement, it needs to be high in the air to work well.

It's not enough to just have a big antenna and to put it high up in the air. On receive, the minute electric current coming from the antenna must be transferred to the radio. During transmit, the RF energy must be transferred to the antenna. This is accomplished by a special type of cable called a feedline. The feedline must be the right kind for the RF application and properly installed, otherwise all the work and money put into the entire system is wasted. Fortunately, both the antenna and feedline are inexpensive when compared to the actual radio equipment. It's not costly to do a good job on the antenna and feedline—it's just a matter of the right parts, properly installed.

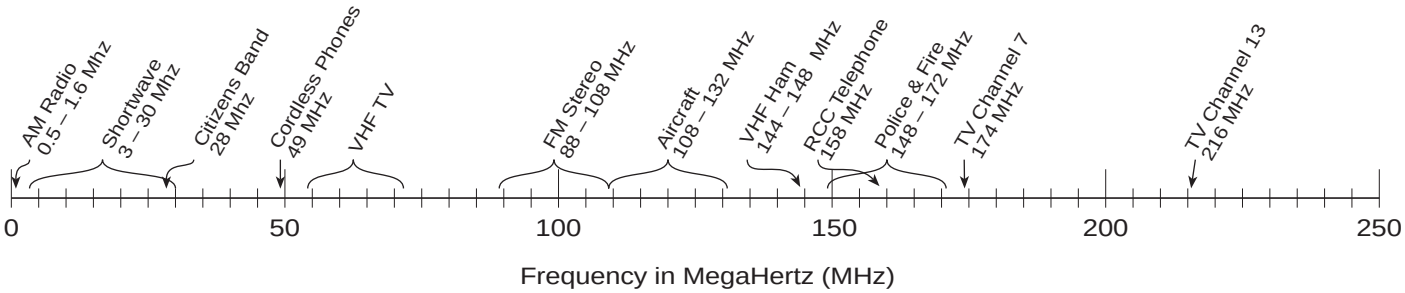
Communications and Home Power

All the electrical power necessary for a major communications system in a back country homestead can be produced by one or two PV modules. This equipment (excepting stuff like big screen TV displays) is very low in power consumption. And this includes two way radio and radiotelephone systems.

Two-way radios, such as CB, ham, and radiotelephone, all come in 12 VDC models. My first choice is to place essential two way communications on its own 12 VDC system. This means that communications has its own PV modules, controls, and batteries. This way there is always power for communications and RF noise generated by the main RE system is less of a problem.

One Way Communication

Here we merely listen or watch a radio signal which is broadcast usually by a radio or TV station. For most folks living in the back country, radio or TV is the only way of regularly and quickly getting the news and weather. It makes little sense to subscribe to the local newspaper if you only get the mail once a month.



AM Radio

These radios are universally available and vary in cost from super cheap to expensive. A buck spent on your AM antenna is worth spending ten bucks on a better AM radio receiver. Here on Agate Flat, we make AM radio antennas out of wire—any kind of wire will do. The wire can be insulated or uninsulated. It can be either stranded or solid. It can be copper or aluminum. All that matters is that the wire is long, and as high as possible above the ground. Consider about 75 meters to be a good starting length Because AM radio is so low in frequency, the feedline is very easy—just plug the wire into the radio's antenna jack. If your radio doesn't have an antenna jack, the wrap the end of the antenna several times around the radio—experiment until your find the configuration that works best.

Shortwave Radio

Here the quality of the receiver is more important than with AM radio. A great shortwave receiver will cost less than $200. Performance will still depend on the antenna which is much the same as the AM receiving antenna—long and high. We use a 300 meter long piece of 17 gauge steel electric fence wire. This wire is galvanized (zinc plated) so it lasts and is cheap—$25 for a 400 meter roll at our local feed store. This very long wire is strung out from our house, over Skookum creek, and to tree on a hill. At the low points, it's about 10 meters off the ground. At the high point, where it crosses the creek, it is about 20 meters from the ground.

Broadcast FM Stereo & Television

With both of these services, you are better off buying an antenna rather than trying to build one. Bigger is better, and higher is better. If you are living in the back country, many miles from the nearest TV or FM station, then you will need the biggest antenna you can get. Fortunately, since FM stereo and VHF TV are in the same frequency range, the same antenna and feedline will work for both. Unless you wish to hear (or view) just a single station, you will need to rotate the antenna because it is directional. The best set-ups we've seen for fringe reception of FM stereo and TV use an antenna-mounted, RF preamplifier feeding the receiver through 75 Ω coaxial cable (called RG-59).

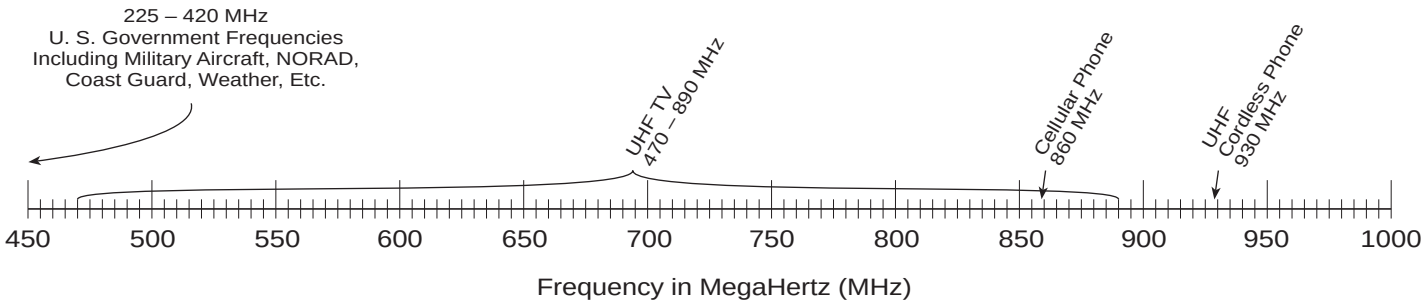
Two Way Communication

Now we're talking. Here you not only get to listen, but also put your two cents worth in. In back country living there is inherently danger. Bummers happen and it's miles to the nearest hospital, fire or police station. In many cases, even the nearest telephone is miles away. Two way radio communications can make a life-saving difference during emergencies and improve life in general.

Citizens Band

CB radio is the lowest common denominator for two way radio communication. You don't need a license and the equipment is cheap and readily available. Once again, the big antenna is king. A $50 CB radio with a $100 antenna will radically outperform a $100 radio with a $50 antenna. CB radios have their transmit power limited by law to four watts. The antenna, however, is not limited. So if you want better CB range, improve your antenna. Even with the best antenna in a good location, neighborhood CB radio communications is limited to 30 to 60 miles in distance. The exception is when the atmosphere is ionized the CB signal can "skip" and bounce back to earth. When the skip is running, I have talked to folks 3000 miles away like they were next door neighbors. While all this is great fun, it is interferes with local communications. When the skip is running, the effective local range of a CB radio is less than four miles.

When you go shopping for a CB radio consider buying one that's designed to run in a vehicle, even though it will permanently mounted at your homestead. Car CB radios are cheaper than the "base" radios because they don't have a 120 vac to 12 VDC power supply and a big fancy case. When you install the CB at your homestead, power it with its own PV/battery system. A CB radio will consume very little current from a small 12 VDC battery. When receiving most CBs consume about 0.2 Amperes, and since the receiver is on 24 hours a day, it consumes about 4.8 Ampere-hours daily. While the transmitter uses more current, it's operation is rarely more than an hour or two daily. All in all, a CB radio will consume less than 6 Ampere-hours daily from a 12 VDC battery. This means that the CB radio can easily



have its own battery and PV for recharging. A 60 Ampere-hour, 12 VDC battery will provide more than a week of operation just on the battery's stored energy. Now add a small PV module such as the Solarex MSX-10 (10 Watts) or the the UniSolar UPM880 (22 Watts) and the whole setup is independently powered. Don't forget to add a charge control to prevent overcharging the battery.

There is a wide selection of CB base antennas—buy the biggest one you can afford. Put it up high. We use four section, 36 foot, telescoping antenna masts designed for TV antennas. These masts are easy to put up, inexpensive ($65), and will securely hold a large CB antenna if they are properly guyed. We attach three or four Dacron® rope guys, using steel "S" hooks, to each telescoping section of the mast. We've never had one blow down. Don't skimp on the coaxial cable connecting the CB radio to the antenna. Don't use the small diameter coaxial cable (RG-58) used for CBs in cars. Use the lower loss, larger coax (either RG-8/U or better yet RG-213/U). Pay particular attention to the RF connectors attached to each end. Most commercially prepared cables come with the connectors (known as PL-259 connectors) only crimped, not soldered, to the cable. The connector, where the coaxial cable attaches to the antenna, should be soldered to the cable if you want good, long lasting performance. Don't forget to ground the mast. This not only makes the radio work better, but adds lightning protection.

What really counts with CB radio is the local network—people. As an example of an effective local CB net, let me tell you of our neighborhood during the late 1970s. At that time, there were more than 20 homesteads, ranches, and radio freaks on our local CB net. The net spanned an area of back country over sixty miles by thirty miles. We were fortunate—two of the CB stations on our net had regular telephones and would relay telephone messages for those (most of us) who were without telephones. A network is effective only if everyone listens. And I mean, really listens—leave the receiver on 24 hours a day and pay attention. But our local CB net wasn't only for emergencies, it was our back fence for visiting with our neighbors. Just about every evening at least half a dozen of us would get together and chew the rag. We talked about everything from pickle recipes to PV module performance to politics. It was the glue that held our neighborhood together. Without the infrastructure of a local CB net, or at least one close neighbor with a CB radio, this type of radio is useless. If you are considering CB radio as essential emergency communications, then you must have another, very reliable CB station within four miles of your location.

Ham Radio

Amateur, or as it's commonly called, ham radio is an old, pioneering radio service. The hams were the first, low budget, homebrew radio communicators. Even in today's hi-tech communications world, hams are still pioneering the frontiers of radio communications. Four of the original participants in our local CB net decided we were ready to upgrade to ham radio. We wanted better communications—more power, more range, more frequencies, and even more delirious people to talk with. We studied hard, took our official Federal Communications Commission (FCC) tests, and we became hams—Brian Green (Wolfhound on the CB and N6HWY as a ham), Dale Hodges (Feather Merchant on CB and KB7HE as a ham), Karen Perez (Small Bear on CB and KA7ETV as a ham), and myself Richard Perez (Jolly Roger on CB and N7BCR as a ham).

Amateur radio is international. There are millions of hams worldwide. You must learn the basics of radio technology and law, then take a test, in order to become a ham. Hams communicate on too many radio bands to even mention. They communicate directly and via ham radio satellites (that's right hams have their own satellites). These communication take place in every communications mode ever invented—Morse code, audio, video, computer data, and more. All you need to do to become part of the action is study up, take the test, and put a station on the air. While buying the radio gear is slightly more expensive than CB, it is worth it.

Perhaps the most useful (and certainly the most popular) ham radio band is the 144 to 148 MHz band

(or as it is commonly called in ham lingo—2 meters). This ham band allows reliable local communication within about a 100 mile radius with the aid of repeaters in the mountains. I can talk to hams in their cars, on hand held radios, or on their base stations—with total and reliable coverage within 100 miles of our remote home on Agate Flat. Over the years, there have been many emergency neighborhood communications handled on the 2 meter ham band. Karen Perez (KA7ETV) owes the sight in one eye to 2 meters, Bob-O Schultze (KG6MM) owes one of his legs to 2 meters, and several neighborhood forest fires were prevented from spreading by using 2 meter ham radio. When it comes to emergency communications, hams get the job done!

While the 2 meter ham band provides reliable local communications, there are many other ham bands. I have talked to hams from Australia to Africa using the shortwave ham bands. Ham radio is your own personal window for global communications. Ham radio is only limited by your interest and energy. Ham radio is very democratic—I've heard everyone from Barry Goldwater to King Hussein on the ham bands. If you are seriously interested in radio communications, then you will eventually be a ham.

Contact your local ham radio club; they run classes to help you get your ham license. Radio Shack has an excellent series of books and videos on getting your ham license. With the new, no Morse code, technician class, it very easy to get licensed and get on the air. Over the years we've become accustomed to the utility of of our ham radios. I'd rather leave home without my boots, as leave without my ham radio.

Ham radio is a non-commercial radio service. Please help us keep it this way. Amateur radio is for ham to ham and emergency communications. It is illegal to use it for business or personal radiotelephone use. If you primarily need communications for your business or to replace the nonexistent telephone, then you need to search elsewhere than ham radio. Which leads us to back country telephone service.

Cordless Telephones

I know several back country homesteads which use regular, and sometimes modified, cordless telephones. In order to make this work you must have a close location where you can plug the cordless phone into the regular hardline telephone system. The 49 MHz cordless phones will work, unmodified, up to about 1/8 mile. The newer, digital, 930 MHz cordless phones will work, unmodified, up to 1/2 mile. Now, these are relatively short distances, but these cordless phones can be hot rodded into working over three to five miles.

Please note that it is illegal to modify these cordless phones. They are strictly designed for very short range operation. If one were, however, to change the antennas on both the base and remote units, these phones will talk for miles on less than one tenth of a watt of power. The cordless handset will need to have a special power supply since it will permanently live miles from its base/charger. The systems I've seen employing the 49 MHz cordless phones use commercially available 50 MHz ham beam antennas which are huge—boom length over 5 meters long. Two antennas are required, one for each end of the system. Both antennas will require special tuning to accommodate the slightly lower frequency of 49 MHz. While I have not seen any 930 MHz cordless phones modified using larger antennas, I see no reason why this should not work over miles in line of sight conditions. If you are living in the back country, then it is highly unlikely that "hot rodding" these cordless telephones will interfere with anyone else's communications.

With this type of service, you get your own distinct telephone number. This is a full duplex service (you can talk and listen at the same time). It is not like the simplex service such as CB (where you cannot talk and listen at the same time). Since you own both ends of the radio system, there are no "by-the-minute" air time charges common to the RCC radiotelephone and cellular telephone services. Unless you are very adept at homebrew electronics, the hot rodded, cordless telephones will not support answering machines, FAX machines, or computer modems. Most of these systems end up costing in the range of $600 to $1000. Don't forget to independently power both ends of the system or your phone will not operate during times of power failure.

Renting Telephone Communications

There are commercial radio services which can provide you with back country telephone service. The two most common types are Radio Common Carrier (RCC) service and cellular telephone service. In both services, you buy the radio gear necessary for your homestead, and the radio service provides the base end of the service which attaches to the telephone network. In both type of services there is a monthly fee and a by-the-minute air time charge whenever the system is used. It is important to remember that the by-the-minute air time charges apply to both incoming and outgoing calls.

RCC Telephone Service

The radio common carrier service dates back over thirty years. It was originally designed as mobile communication for business folks on the move. It is gradually being replaced by cellular telephone in most

areas, but is still the only commercial R/T service in many back country locations.

RCC is usually a simplex service (push to talk, like a CB radio). There is usually a mobile operator who routes all the incoming and outgoing radio traffic. There are often many folks using the same RCC frequency, so it is not uncommon to have the service in use, or already busy, when you may wish to make or receive a call. The folks I've known who have tried to run a business using RCC service are generally disappointed. It is difficult to conduct business on a simplex radio. The person calling in is holding a regular telephone in his hand and has a lifetime of telephone habits telling him that he can interrupt you while you are speaking. Being simplex, you can't hear your caller while you are talking. This easily leads to confusion.

RCC equipment is not very expensive. A complete setup for a homestead will cost around $600 and can span many miles of space because the transmit power is in the range of 25 watts. Connect charges and air time charges are generally less expensive than cellular service.

Cellular Telephone Service

The cell phone is gradually replacing other mobile telephone services. Cellular telephone offers full duplex service in the 800 MHz UHF band. Because the cell phone band is at so high a frequency, communications is limited to pretty much line of sight. If you are fortunate to have a cell within radio range of your homestead, then this service works well, although it can be expensive if you use it a lot. For example, cellular companies generally charge between $20 and $40 monthly and an air time charge of between 20¢ and 50¢ per minute. If you are a business, such as Home Power, then your telephone is probably in use constantly during business hours. The cellular air time charges alone can add up to well over $1,000 monthly in this scenario (and this doesn't include regular long distance charges).

The cellular phones themselves are inexpensive. Some cellular services will sell you a phone for a penny when you sign up. These hand-held cell phones work great if you are close to a cell site. If you are further from a cell site (say over ten miles or have large obstructions such as mountains), then spend the extra money to get a more powerful cellular telephone which will accept an external antenna. A good cellular telephone antenna located high up on a mast will radically increase the cell phone's range.

Some cellular telephones can accept common telephone appliances such as answering machines, FAX machines, and computer modems. Some do not allow use of these devices. Check these functions out before you buy your cellular telephone.

Your Own Radiotelephone System

If you use a radiotelephone often, say more than an hour daily, then it is much cheaper to buy and operate your own radiotelephone system rather than using cellular service. It's like being your own cellular radio company with only one user—you. The radio gear is inexpensive compared with big time cell phone use, or miles of newly installed telephone hardline.

You will need a location with a regular telephone line to install the base end of your R/T system. The base station will route your communications traffic directly to and from your own telephone line. The telephone company bills you just like any other regular ol' telephone—no by-the-minute air time charges and no charges for incoming calls. The base unit will broadcast your phone traffic to the remote (known as subscriber or sub) unit at your homestead. If you have line of sight between the base and sub units, then a few watts of power works great at distances over ten miles. If you have an obstructed radio path, such as mountains in the way, then you will need to run more power and also operate the R/T at a lower frequency. The type of radio gear, antennas, and frequencies of operation, all depend on your physical situation. The R/T gear usually operates in either the 150 MHz VHF band or the 460 MHz UHF band. If you don't have a line of sight radio path, then try to use the VHF band as it works much better around and through obstacles. Transmitter output power levels vary from two watts to 25 watts.

Radiotelephone systems must have their frequencies of operation assigned by the Federal Communications Commission (FCC). Generally, the vendor of the R/T system licenses the system with the FCC. Frequency space can be a problem, particularly on the VHF bands, in some areas of the country. The UHF R/T band at 460 MHz is still more open in most places.

These R/T systems provide full duplex service and support all phone appliances such as answering machines, FAX machines, cordless phones, and computer modems. The power levels required are small and it's a snap to put both ends of the system on independent solar electric power. While these R/T systems will cost between $5,000 and $7,000 to install and power, they cost less than six months of heavy cellular telephone use. Once the system is bought and installed, they are as cheap to operate as a regular hardline telephone.

There are many important details when installing your own radiotelephone system. If the system is to work well everything must be perfect. To this end, I have

written another article, published in this issue on page 50, which describes Home Power's radiotelephone system. If you follow the guidelines in this article, then your R/T will work well and be cost effective.

Talk, talk, talk…
This article gives you an overview of your options for back country communications. The type of radio communications you choose to use will depend on your communications requirements, how far out in the back country you are, and your budget.

The bottom line is: If you can power your homestead using renewable energy, then you can have all the communications you desire. Just as not having the commercial power lines is no longer a insurmountable obstacle, neither is not having the telephone lines. We can use radio, spanning miles of space, to do the job for us.

Access
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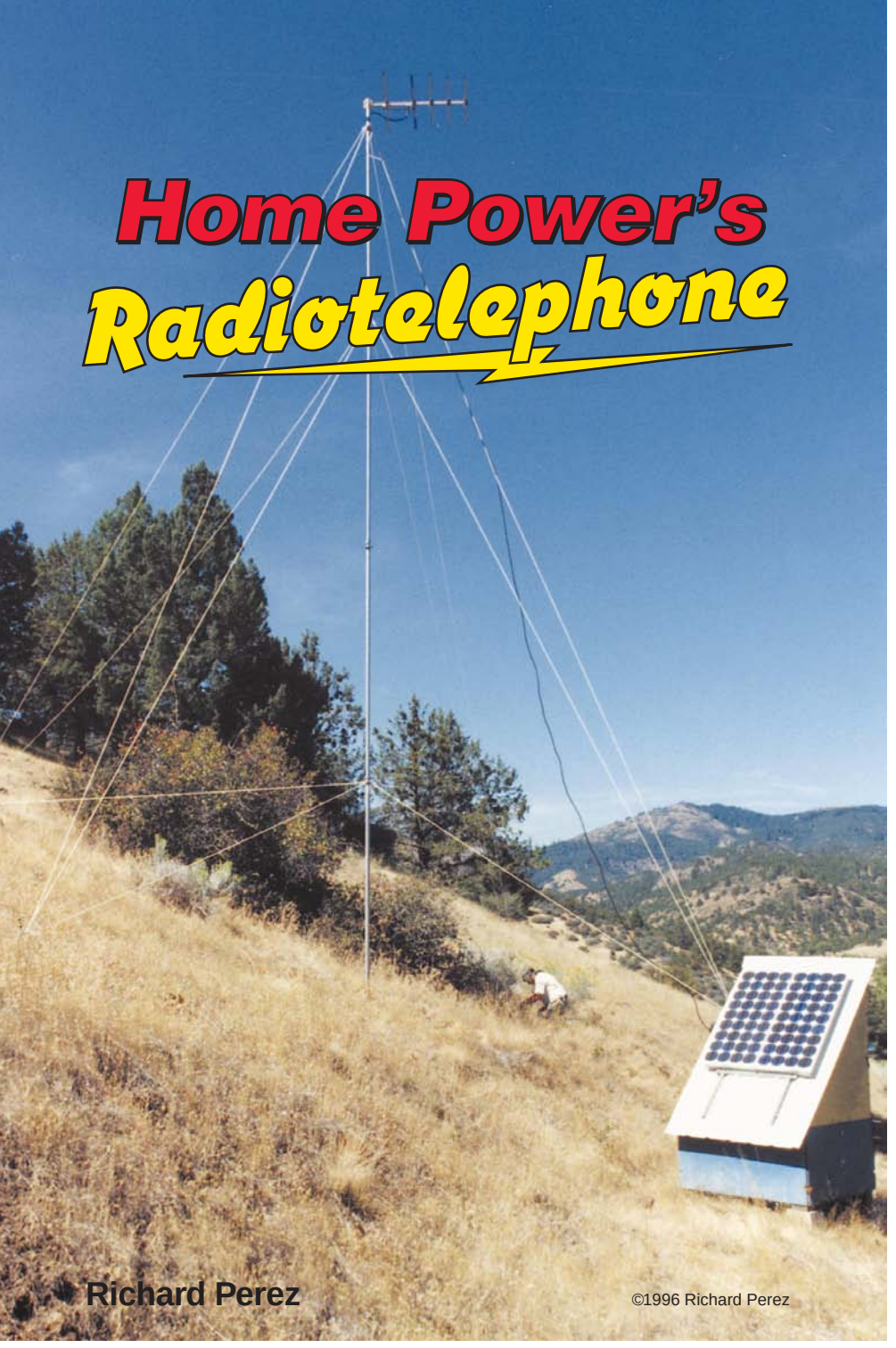
telephone and FAX: 916-475-3179
(yes, it's a radiotelephone!)
Internet email: richard.perez@homepower.org
(yes, we access the Internet via our radiotelephone!).
Hams: we monitor 146.400 MHz simplex all the time.



When moving to the back country you usually get three things: no grid power, no hardline telephone, and a bad road. Technology allows solving the first two and we're still working on the third. Homesteads beyond the grid are often beyond the phone lines. The expense and right of way problems which make commercial electricity impractical also prohibit running in telephone lines. You can have a telephone without wires—use radio!

Radiotelephone

See the article on page 42 for the basics of radio technologies and operation. Radiotelephones (R/Ts) can provide regular phone service using radio links instead of wires. One end of the radiotelephone system is located where the telephone hardline service is. This end is called the "base." The base radio plugs into the regular telephone hardline(s) and transmits the incoming telephone signal via radio to the other end of the system, called the subscriber or "sub". The sub end of the R/T receives the radio signal from the base. The sub also transmits the outgoing telephone signal from the remote end back to the base unit which in turn places the outgoing signal on the regular telephone lines. Both the base and sub units contain a transmitter and a receiver. Both transmitters operate when the phone is being used (off hook in phone lingo). The system is full duplex, which means you can talk and listen at the same time—just like a regular telephone.

Power consumed by an R/T system is very small. The transmitters vary in output from 2 watts to 25 watts. Receivers operate 24 hours a day and usually consume less than 4 watts each.

The daily energy consumption of the R/T system depends on how much the phone is used. Ours is used about 7 hours daily. Each end of the R/T system (which has a 2 watt transmitter) consumes under 200 Watt-hours daily. If your R/T has higher powered transmitters to span longer distances, then the energy consumption will be higher. For example, an R/T system with 25 watt transmitters and a usage of 7 hours daily will consume about 500 Watt-hours per day at each end. These are relatively small amounts of energy and each end of the R/T system can be powered by one or two standard PV modules.

For battery storage, I tend towards overkill. Communications is an essential service. Our safety and our livelihood depend on good communications. I don't want the R/T to cease operating just because we've had six or seven cloudy days in a row. Most R/T systems can be powered directly by 12 VDC. A radiotelephone with a 2 watt transmitter is best served by a 100 Ampere-hour battery. This gives a week of battery storage even under heavy use. The higher powered 25 watt R/T units will require a larger battery—about 250 Ampere-hours. Sizing the system is just like sizing any other PV system, except oversize the power components by a factor of two or more for reliability.

R/Ts also operate on a variety of frequencies. The two most popular R/T bands are around 150 MHz (VHF) and 460 MHz (UHF). The VHF models are better when there are obstacles (such as mountains and forests) in the radio path, and the UHF models work well when the radio path is unobstructed (line of sight). The VHF band is far more populated. The VHF band is full in many areas and most frequency pairs (two transmitters, remember) are already occupied. If you live very rural, then chances are that VHF frequencies are still available in your area. If not, then try the UHF band and set the system up with line of sight between the base and sub units. In either case, R/Ts use antennas which beam, or focus, their radio output in a single direction. As with any form of radio, bigger and higher antennas are better. Every R/T transmitter must have its frequencies specified and licensed by the Federal Communication Commission.

Left: Custom made Scala antennas are built to match the radiophone's frequency. The antenna on top of the mast is for 2 meter ham use.

Above: The guts of the Carlson Optaphone.

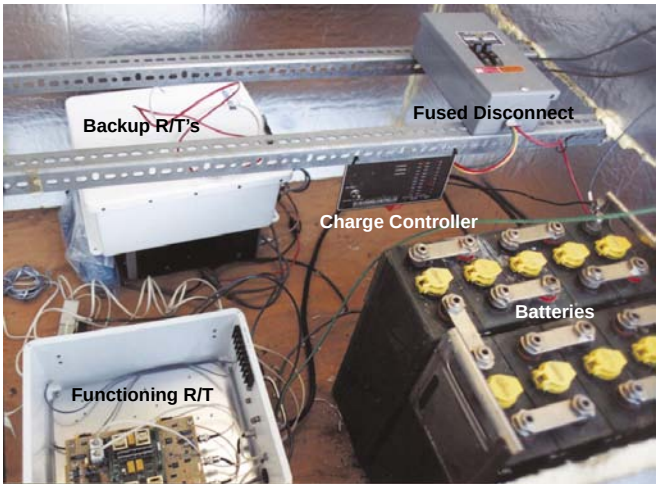
Home Power's R/T

We are currently using Carlson Communication's Optaphone 2000 radiotelephone, a two line system. The base end of the Optaphone is connected to two regular telephone hardlines, each with its own telephone number. This unit replaced a single line Optaphone because everyone at Agate Flat got tired of fighting over the phone. Home Power is a communication business. We needed another line to run FAX and computer modems. Being info nerds, we'd like to run both lines at once.

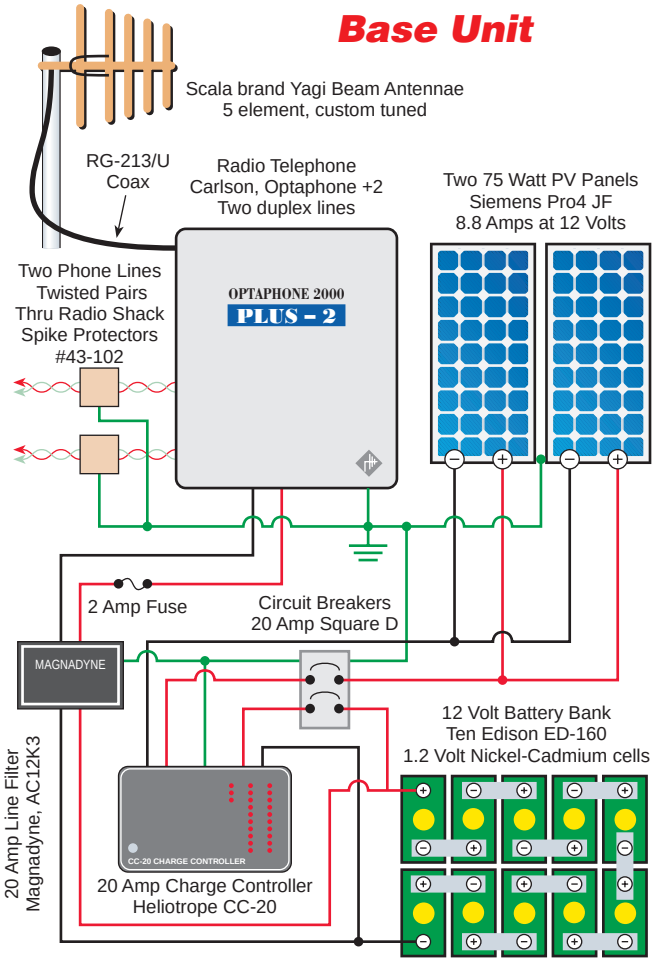
Our R/T system spans six miles (9.6 km). This short distance would be duck soup if there wasn't a mountain located directly in the radio path. It blocks enough of the RF signal to make UHF R/T unusable. We know this because since our first R/T in 1988, we've tried two different UHF radiotelephones. These were very noisy and sometimes didn't work at all even though they were 25 watt transmitters feeding multiple element beam antennas. We moved to the VHF band and everything started working regularly.

The Base

Our near and dear neighbor Stan Krute, allowed us to place the base of our R/T on his property. Stan has been PV-powered for years (two miles off-grid) but his property has access to the hardline telephone system.

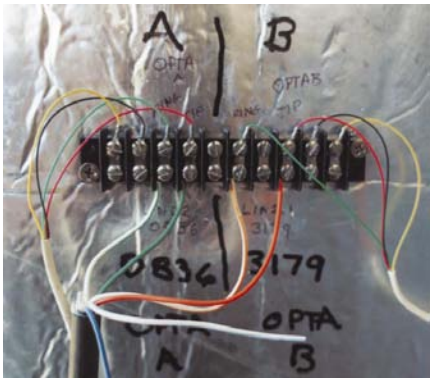


When we installed our first R/T, Stan let us mooch power from his home PV system. We couldn't afford our own PV system at the time. While generous, it was a bad idea. Stan's inverter noise and occasional low voltage caused unreliability in our R/T. If your neighbor is generous enough to allow your base end on their property, don't ask them to also supply the power. Also don't rely on grid/utility power at the base end of the system. Consider the high cost of the R/T system and its low energy requirements, then spend the relatively minor amount of money for an independent power source.



Left:
Inside the R/T shed at the base end.

Right:
Colored spaghetti where the R/T meets the hardline.



Our two phone hardlines run from the Telco phone lines to the side of Stan's house. From there we dug an 800 foot trench up the hill to a high site for the base end of the R/T. We put four pairs of phone wires in the trench, even though we were only using a single pair at the time. Recently we hooked up one of the other pairs for the new two line system. If you are going to trench phone lines, install at least twice as many pairs as you think you will ever need. Wire is cheap compared to the cost of trenching. This way the failure of a pair or the addition of another line will not require too much more work.

The base of our R/T lives in a small (4 feet by 4 feet by 6 feet high) shed high atop a hill behind Stan's house. This shed is superinsulated. The buried phone cables run into the shed and attach to the actual radiotelephone. The roof holds two Siemens PC4JF PV modules. These provide more than enough energy to run the R/T even in the most cloudy weather. The energy is stored in a 160 Ampere-hour, 12 VDC battery of ten series-connected Edison ED-160 nickel-cadmium cells. We use alkaline cells because the shed gets cold during the winter. Both the battery and the PVs

Right:
A Magnadyne filter keeps noise from entering on the power lines.

represent radical oversizing. I want this system to work and recharge rapidly during extended cloudy periods. We use a Heliotrope CC20 PV control to prevent overcharging. We also use a Magnadyne power filter to keep the charge control PWM noise out of the R/T signal.

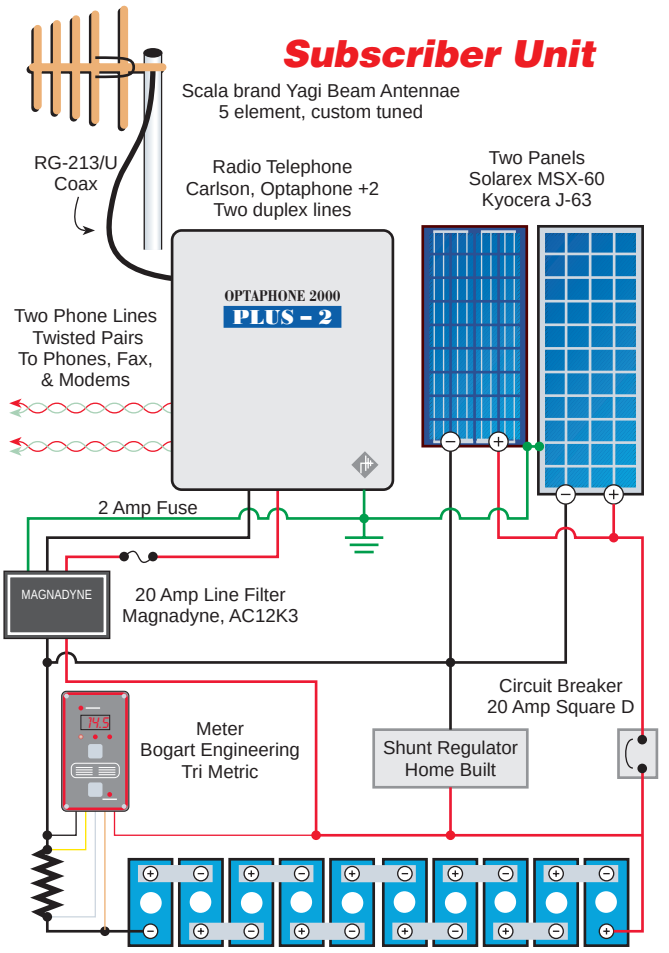
The base unit uses a five element Scala antenna on a 36 foot telescoping steel mast. This antenna both transmits and receives the phone transmission to and from the

The Subscriber End on Agate Flat

Six miles from the base end of the R/T, our sub antenna receives the signal transmitted from the base unit. The signal is passed from another five element Scala beam antenna to the Optaphone, which in turn operates our phone appliances. We have two regular telephones, two cordless (one 49 MHz and one 930 MHz) telephones, a FAX machine, and three computer modems on the system.

The sub end is powered by a Kyocera J63 and a Solarex MSX-60. We made a homebrew shunt controller to keep these modules from overcharging the 100 Ampere-hour, 12 VDC battery of ten Alcad UHP100 nickel-cadmium cells. We also have a TriMetric Amp-hr meter attached. This PV system is totally independent of our main PV/wind system. This prevents electrical noise from effecting the phone and means that if we deplete the house system we'll still have power for communications.

Use the best antennas you can find. We replaced the consumer grade Cushcraft four element beams with commercial grade five element Scala beams. They are custom tuned by the factory for our specific transmitter frequency. The Scala antennas are very well constructed and many times stronger than the old lightweight antennas. They are expensive, but well worth it and a minor cost in the big picture.



month ago. The audio levels are a little low so we'll send it back to Carlson for tweaking. This "try it and tweak it" break-in period is what we've come to expect with our marginal RF path. Those with a line of sight path will find that their R/T system will work well right out of the box.

Obstructed RF paths can use a repeater to beam the radio signals around obstacles or for longer distances. If we can't get our new two line system to deliver the

R/T System Performance

This R/T system has worked well over the years. We have tried Ritron, Telemobile, and Uniden systems before settling with the Optaphone. My only complaint is the slow speed (2400 baud) we have to run the modems. Those with better radio paths will see much better (up to 9600 baud) speed. The FAX and answering machines have no problems with the R/T system. Most folks don't know they are talking to us through a radio link. We installed the two line Optaphone about a

Below: The R/T's independant 12 Volt Nickel Cadmium battery bank

Above: Old Antenna, New Nerd...New Antenna, Old Nerd.

modem speed we need, then we may add a repeater. The drawback of a repeater is that it doubles the system's cost and complexity.

Radiotelephone System Cost

Home Power's complete R/T system cost about $8,000. While this seems like a lot of money, it is inexpensive when compared with our only option, cellular telephone. Considering our heavy phone use, it would cost about $2,000 per month just for the cellular air time. With an R/T system, the phone company bills you just like any other telephone—no by the minute air time charges.

Folks who only need a single telephone line can buy and install an R/T system with PV power at both ends for around $5,000. Home Power's system is designed for heavy-duty use with mega overkill on the power systems.

Radiotelephone System Cost

Quan	*Item*	*Cost*	*%*
1	Optaphone 2000 R/T	$4,520	56.5%
4	PV Modules	$1,600	20.0%
2	Scala Beam Antennas	$520	6.5%
2	Ni-Cd Batteries (Recycled)	$500	6.3%
1	Shed- Base End	$200	2.5%
800	feet of Buried Phone Line	$160	2.0%
2	Telescoping Masts	$130	1.6%
2	Coaxial Cables	$120	1.5%
2	Charge Controllers	$100	1.3%
	Power Wiring & Disconnects	$55	0.7%
	Rigging and Guy Rope	$50	0.6%
2	Phone Line Filters	$39	0.5%
	R/T System Total	$7,994	

Many Thanks

This short article cannot begin to give you an idea of the time and help from others that it required to get us reliable telephones here on Agate Flat. I want to thank Bob-O Schultze of Electron Connection (a pro designer and installer of many R/T systems) for the countless hours he put into making our system work well. Thanks to Stan Krute for allowing us to use his property for the system's base end. Stan hardly complained when we first located our R/T antenna close to his TV antenna and blitzed his TV reception. Thanks to Carlson Communication for working with us on what amounts to a really marginal radio path and a very difficult job.

Access

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Antenna Maker: Scala Electronic Corp., 555 Airport Drive, Medford, OR 97504 • 541-779-6500 • FAX: 541-779-3991 • Internet email: mail@scala.net

Nepal PV Upgrade

Dennis Ramsey

Many Home Power readers followed the cover story in Home Power #45 of my PV lighting installations in two remote Nepal monasteries. That was over a year and a half ago. Since then, Richard and Karen Perez of Home Power donated a third PV module to Pungmoche, so I decided to donate a third one to Tumbuk. Why waste time! Besides, in the traditional Buddhist communities here, it would be a faux pas to improve one system and not the other.

This was my fifth trip to the Junbesi valley in the two and a half years since I did the first installation at Tumbuk. Whenever I'm there I make the rounds of all the PV installations in the area. There's Hillary School with two 35 Watt modules, a UHF radiotelephone system with one module, one private home, and three monasteries that all have PV systems. Even in the most remote parts of this world, PV is catching on.

Above: Tumbuk monks enjoy tea and PV.

Journey Begins

The journey began in mid-November, 1995. I boxed and shipped ahead two more Solarex MSX-50 PV modules and two dozen more Enertron Quad compact fluorescent lights. The plan was to enlarge the arrays of both monasteries by half. I thought I would simply enlarge the array frames I had constructed in 1994 to accommodate a third module each. It seemed pretty simple.

My plan was to do the welding in the field. I flew myself and the gear to Phaplu, Solu Khumbu, then hiked up to both monasteries and got the frames down. We strapped the modules (now three) to the roofs by stringing 12 gauge house wire through the frame holes and wrapping it around nails in the roof boards. We left it that way until I finished modifying the frames. The year before when I visited, I had seen a lot of welded angle-iron window frames and roof joists around the township of Solari. I had assumed, wrongly, that there was a welding shop nearby, since this town boasts a very well-managed Swiss hydro-generator and its own mini-grid. I located a modern hi-tech welding machine with flux rods, which was a very lucky find in the remote mountains. I was lucky enough to find the arc welder, but the area is remote enough that I could not find the angle iron I needed. Finally, I had to take the frames back to Kathmandu by helicopter and do the work there.

Auspicious Timing

Because it was so late in the year and all airports in the mountains were scheduled to close soon for the winter, I opted to leave for India until February. In February, I was waiting in Kathmandu to catch the first flight back to Phaplu airport after winter. My situation was complicated because the frames were now too big to fit into the cargo door of a fixed-wing aircraft. They had to go by helicopter. Finding out which companies are flying which days is not easy. There are several private companies, and their schedules are unpredictable. Their existence is also a bit sketchy from week to week, depending on whether or not they've smashed their aircraft.

I had been told by one company that a Khumbu businessman had chartered an entire Sikorsky helicopter to fly some goods into Phaplu—exactly where I needed to go. I was told that the helicopter was totally jammed, but that if I showed up early in the morning at the airport with frames in hand, he would probably take them. This would free me to go by any aircraft available, so I took the frames to the airport the next morning. He was a very nice guy, and gladly took the frames.

As I was chatting with him, Eberhard Berg came up and tapped me on the shoulder. We both shouted our surprise. Eberhard and his wife Vrenie, are the Swiss anthropologists who originally donated the PV equipment for Pungmoche. I had been sad that they had finished their research and left Nepal last year. I didn't know if I would ever see them again, and they had never actually seen the lights on at Pungmoche! Coincidentally, Eberhard was on that day's fixed-wing flight to Phaplu! As we talked before his flight, it was

Above: Mounting the new module at the Pungmoche Buddhist Monastery.

clear that he wouldn't stay long in the valley. Even if I were able to catch a flight to Phaplu in a few days, Eberhard would already be out of the area. Finally we said a poignant goodbye as he passed through the security curtain and went to his gate.

I wandered over to the enormous pile of goods going by helicopter, and began chatting with old Sherpa and Tibetan friends. They told me they had found space on today's flight for me! I was desperate to go, but I didn't have my rucksack prepared. They said I had about 30 minutes to get it together. I bought my ticket immediately, then bolted for the door to grab a taxi to rush home.

As soon as I hit my front door ten minutes later, I ran through the house upstairs and down, throwing things at my rucksack. I had ten minutes to pack. I forgot food, towel, water filter, and my medications, but managed to bring all the right tools and spare parts. I arrived at the airport and shot through the curtain hoping to find Eberhard, but his plane had left. If there were too much lag time between our flights, I wouldn't even see him in Phaplu or for many days, if then. Sure enough, when we finally reached Phaplu in the Sikorsky helicopter, Eberhard was long gone. I hired my porters for the trek to Junbesi, and went into a lodge to eat lunch. I was bummed-out, in spite of the day's good luck.

I couldn't even focus on lunch, and afterwards went into the toilet out back to contemplate the rest of the day. I grabbed the door knob to leave, just as someone on the outside grabbed the knob to enter. In unison we swung the door open. I was nose to nose with Eberhard! The essence of auspicious timing!

We walked for four hours together, then separated to go to two different monasteries. We agreed to meet in three days to go to Pungmoche. It would be Eberhard's first visit since May 1994, when we laid wire there together for six days. He and Vrenie had not been back to Pungmoche since then. They had to leave before the work was finished, while I stayed to install the array and battery bank.

Cultural History of the Tumbuk PV System

In the meantime, I hiked up to Tumbuk Monastery at the opposite end of the valley. I discovered some interesting things. Apparently, as soon as the system was up and running (150 watts of lighting), and with a full battery bank of 400 Ampere-hours, the monks left all the lights blazing—every night. It took only a short time before the batteries went flat and sent the system into

Below: Ngawang Zimba is pleased with his newly enlarged array.

Low Voltage Disconnect (LVD). At that point, they began to drain the batteries flat every day after the system reached reconnect voltage, cycling 20 to 30 Ampere-hours in and out of the battery daily. This went on every day for many months. The batteries never came up to full voltage or equalized. In effect, the battery bank idled at about 20% state of charge for at least nine months. I realized that it was only the monks' experience with the LVD circuit that caused them to physically understand the limits of the volume of energy they had at their disposal. Once the first 400 Ampere-hours were gone they couldn't leave the lights on all night. They had to learn to conserve, if they wanted lights at all. And it was also the LVD circuit that saved the batteries from being destroyed altogether. Without the LVD in the controller (the cut-off is 11.5 Volts), the inverter (with a low voltage cut-off at 10.5 Volts) would have functioned as the de facto LVD. The bank would have cycled even lower in its range and the batteries would have been wrecked.

So the question became, "How to help them conserve?" I brought Tumbuk and Pungmoche both a fresh dozen Enertron 9 watt Quad CF lights (they're still $10), and used them to replace all of Topkay's larger lights in the Tumbuk complex. We were able to reduce consumption by 25% by lowering the bulb wattage. I also added a third 50 Watt PV module, increasing their energy input by 50%. And, I added a Dura-Pulse battery conditioner to improve the health of the bank. When I left Tumbuk in mid-February 1996, the battery was hovering close to full charge for the first time in two years!

Below: Dennis explains PV wiring.

Above: Ngawang Zimba and Eberhard Berg.

I concluded that we need smarter controllers, even if consumers had to wait more than one day to recharge the system! But hey, this is the truth! People have difficulty controlling their consumption habits, and the planet shows it. It's true of everyone—me, you, and lamas in remote monasteries. If the power is there to be consumed, and if it's "free", it gets used. This is why there are no second-hand stores in the Third World—nothing that is there as a resource goes unused. This applies to shoes, dishes, and energy.

The people I provided with this electricity have no history of "surplus and how to manage it" like we do in the West. They have a history of "needs and how to manage them," vis-a-vis a very limited resource base. These are quite different cultural experiences and they need different charge controllers. This is true especially for Third World applications, where the users are not technically oriented. We need controllers that take over when the system is being over-used.

The brain of the system must effectively control energy consumption and run an equalization charge regularly, or there are going to be a lot of dead batteries to recycle. In small countries that have no recycling facilities it wouldn't be right to ruin batteries with mis-adjusted charge controllers. I must admit that part of the

Above: Tumbuk Monastery and its PV array.

problem is design error on my part. I designed a tightly budgeted system based on nominal component ratings. I am more aware now that the charge controller has so much to do with the overall health of the batteries. Comparing the controls of the Tumbuk and Pungmoche systems is a good example. These systems are identical except for the charge controller.

Tumbuk has an SCI 12 Volt, 8 Ampere controller with LVD. Factory set points are: LVD at 11.5 Volts, reconnect at 13.5 Volts, and high voltage PV cut-off is at 14.3 Volts. Pungmoche's controller, by contrast, is an SCI 12 Volt, 16 Ampere model without LVD, and with a trim pot to set the high cut-off. LVD is done with an SCI Battery Saver with trim pots for LVD and reconnect voltages. My settings are LVD at 12.5 Volts, reconnect at 13.5 Volts, and high cut-off at 14.8 Volts. If you can wade through that you see that Pungmoche's battery bank is cycling higher than Tumbuk's. It also comes up to an equalization charge when it reaches full.

The pattern of use also has a big impact on battery health. Pungmoche is really a seasonal school so there are long periods when there is not much of a load. But Tumbuk is primarily a residential monastery, permanent home for at least four people. Tumbuk has deeper battery cycling, a heavier average load, and no chance to come to full charge. Any reasonable amount of sun will bring the voltage up to 13.5 Volts, and the controller then reconnects inverter to battery. All of the day's energy is burned-off that night, and the system goes again into LVD. This cycle can go on and on if nothing prevents it.

Technical Concerns

After using and troubleshooting these systems, I have technical concerns about the equipment I am using. The SCI charge controller seems to have an important design flaw. The low voltage disconnect load output is undersized. When a 250 watt inverter is maxed, this is 2 amperes on the 120 vac side, but 20 Amperes on the DC side. The SCI controller's LVD circuit is rated at only half this amount—10 Amperes! This means that the SCI's LVD circuit is only capable of handling about 120 Watts of power. In the installation at Tumbuk, this wattage is almost exactly what they use nightly, so there isn't a problem. I am concerned about what will happen if they use more lights. But across the valley at Pungmoche, there are 23 lights on an identical inverter, and they often have more than half of them on. As fate would have it, I didn't install the same SCI controller at Pungmoche, but a non-LVD SCI model, with a separate SCI Battery Saver. The battery saver unit has a 20 Ampere LVD circuit, that saves Pungmoche from inexplicable shut-downs (if I had installed a controller like Tumbuk's). But I have problems with this particular design parameter on SCI's part. Their 8 and 12 Ampere charge controllers both have a 10 Ampere LVD circuit. It would seem reasonable to assume that a user of a 12 Ampere PV charge controller would want to run more than a 120 Watt load on the LVD side. It makes good sense to me that if you reckon from the maximum amperage on the input side, which is 12 Amperes of array power, going to the batteries at a planetary average of four hours a day, this equals 575 Watt-hours average for a day. An average planetary evening (defined as the time between when people come indoors and when they retire) is also about four hours. 575 Watt-hours of daily input divided over 4 hours of evening usage, is 144 Watts per average hour, and equals at least 12 Amperes DC of load at any given time.

I also had a potentially severe problem with the Dura-Pulse units I installed in three monasteries. The units supplied to me from the factory were not the units I had ordered. Two of the three were mis-adjusted, and would have ruined other equipment if Greg Holder of Alternate Means had not caught the problem. I'm wondering how many other users had wrong units supplied to them. In my case, faulty units could potentially destroy a lot of work at a remote site, and this would have been a

hardship for me as well as the monasteries. I had to open the units' enclosures and change several internal pins in order to use these at my voltage. A less savvy consumer would not have noticed this, and might also not have noticed that their system had a long term problem. This could give pulse technology a bad rep!

Learning Curve

I learned a whole lot about reality versus abstract design. There seems to be confusion about what's real versus what's nominal. For instance, if we figure all equipment to be functioning at its rated capacities (that's nominal), we are working with an abstraction that is not true in the field (that's reality). Nominal ratings are only true in controlled circumstances in testing labs. These ratings were created primarily, I think, so that consumers and manufacturers could compare one product with another in order to assess relative value. So, nominal ratings are a bit like a diamond in the rough—some setting and fine tuning is necessary before we get something we can recognize.

What led me to begin thinking in these terms was a problem in my systems. If my equipment had simply performed as per its nominal ratings, there would have been no problem. I began to analyse my systems in detail from modules to light bulbs, to try to understand where all the power was going.

I surveyed the wiring and found all to be OK. The only potential source of voltage loss was the 10 gauge type TC wire running from the inverter to the battery bank. The distance is under eight feet and the max current possible through a 250 watt inverter is 20 Amperes, but I doubled the wire with another length of 10 gauge TC. I also installed a small 1.5 Watt, DC fan in the door of the control box to cool the inverter and controller. Since I didn't have a larger controller (the SCI ASC is an 8 Ampere model connected to a 9 Ampere array), I figured it would help if the unit had some air flow.

The real problem was that there was not enough energy, even though the nominal calculations said there should be enough. I started by measuring the exact load. I used my tester between the terminals of the DC switch that feeds the inverter. This turned the inverter on so I could see what its idle current draw actually was. I let it warm up, then turned on lights one at a time, then five at a time, and finally full on. I was able to get a very specific idea of the true load on the battery. Tumbuk uses about 27 Ampere-hours per day to run the lights it needs. With their original two module, 100 Watt PV array, this is about all they got each sunny day. So, they were idling, at whatever voltage or state of charge. The state of charge they descended to was the LVD point. And they stayed there for a long time while the batteries sulfated. It would probably have been

Above: Author Dennis Ramsey.

wiser to have used a 100 Ampere-hour battery and cycled it harder, rather than a 400 Ampere-hour bank that can never attain a full charge. The original reason for the 400 Ampere-hour battery bank was to give them winter storage capacity. Even though the bank was full when the system was first turned-on, they habitually used more than their daily input. The controls and the users are both unsophisticated, so there was nothing to prevent the battery voltage from devolving to the controllers' lowest factory pre-set.

I would have been able to get an immediate grasp of array power flow, if I hadn't managed to burn out the 10 Ampere side of my multimeter at this point. But at the same time, this caused me to have to use the hydrometer and voltage side of the tester to do the same thing. This is arguably more accurate for determining state of battery charge anyway. Necessity and lack of proper tools sometimes helps our learning curve by teaching us new tricks. I recognized that the batteries were suffering. Even though the specific gravity was nearly equal between cells, it didn't jibe with what the voltage should have been at that specific gravity. I also could see deep within the cells that crystals were growing around the busses and plate edges. My conclusion was that this damage was caused by the cells sitting in a state of low charge for a long time. The only solution I had at hand was to install the Dura-Pulse, and the third 50 Watt PV module, change the bulbs to a lower wattage, and let it operate for a while. I also counseled the monks every day to please not use any more juice. I'm expecting the battery bank to slowly rise to full charge over time and then stay there, ready for winter.

I eventually was able to conclude that the real problem with the Tumbuk system was not that the equipment wasn't performing at its nominal ratings. It was. The real world problem was a combination of less insolation than originally thought, damaged batteries, and inadequate charge controller set points.

I am happy to report that there was not a single burnt-out ballast or bulb at either monastery in the last year and a half. In fact, there was only one bad ballast amongst the whole lot, and these lights have been used almost daily for two and a half years.

Journey to Pungmoche

I left Tumbuk and journeyed down to the town of Junbesi to rendezvous with Eberhard. We ate an early lunch and then started our slow ascent to Pungmoche. The frame and other gear had been sent ahead by porter. We had only one day to install the new frame. My plane was to leave in two days, and Eberhard had to leave the next day to follow a pilgrimage to the South. We were quite tired when we arrived.

The dogs were beaten back and we were invited into the kitchen for a bowl of soup. It had been snowing off and on for days, and it looked like it would start again. We thought it best to begin immediately. This was not the kind of weather to be standing on top of a sloping metal roof and looking down a hundred foot drop-off.

Ngawang Zimba, the Lama of Pungmoche, had done a very smart thing ten weeks before when I had removed the PV array's frame. He had a carpenter from the neighboring village come and build him a wooden frame for his three module array. It fit just like it should on top of the old swivel base. Ngawang Zimba had been adjusting his array daily all winter long, and with the added module, courtesy of Home Power, his batteries were nearly topped-off. It also helped that the school was closed for the winter and the students sent home to their villages. There hadn't been much consumption over the winter season.

We exchanged the wooden frame for the iron one just as it began to snow. Eberhard and I laid all our assembled tools and components on the stone floor of the courtyard under the eave of the roof. Taking down the array was easy since the roof hadn't gotten slippery yet. Wood is also much lighter than iron. We swapped the modules into the iron frame on the floor of the courtyard, then four of us heaved it gently onto the edge of the roof. We got it to the ridge and three of us tried to lift it and set into its pipe. One pipe inside another pipe should be simple. No way! We stood in the cold drizzle on a slick, sloping roof, turning blue, while trying desperately not to slip off or drop the array. It was heavy, we were tired, and we were stuck.

The carpenter who had made the wooden frame was in the courtyard below, and he saw our plight. He adroitly walked barefoot up the ladder, no hands, swung out over the abyss. He stood on a four inch piece of the tiny window frame under the ridge pole. He lifted the frame almost by himself, and we were able to guide it to its mount. Amidst the shouts and laughter, I could have sworn I heard him make a dirty crack about what's so hard about one pipe inside another pipe.

Since the batteries were in such good shape, I installed a small DC fan in the control box door, a Dura-Pulse for insurance, lowered the bulb wattage, and called it done.

My hope is that these PV systems will last a long, long time. Provided the batteries don't go bad due to under charging, they just might. It helped tremendously to add a third PV module and a Dura-Pulse to each system. I must say that Trace now makes a charge controller (the C12) with a brain, that is user adjustable over a wide range, and has auto equalization. This should solve most of my problems.

Cheers from Nepal!

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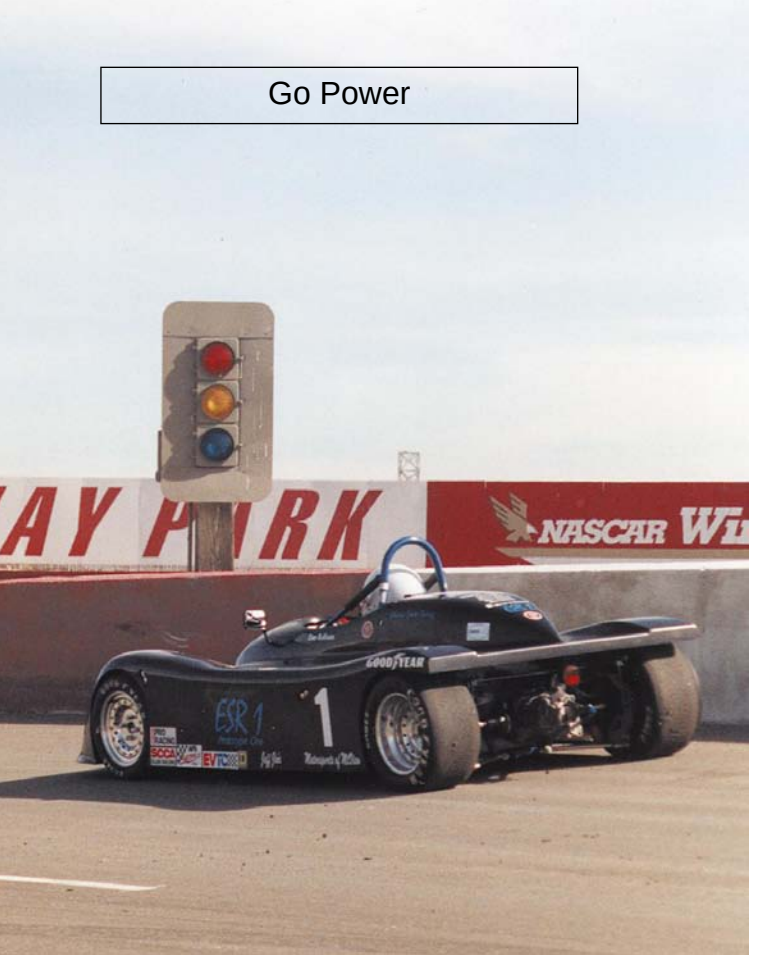


EV RACING: Life in the Fast Lane

Shari Prange

Last time we talked about different types of race cars and how they relate to the world of electric vehicle racing. We looked at the differences that distinguish one type of racing from another. Now let's take a look at some of the things different types of racing have in common. We'll go behind the scenes and see some of the preparations and requirements that aren't apparent from the grandstands, especially to new racing fans.

Backstage Passes

Events like club rallies and the American Tour de Sol are intended for normal electric passenger cars. The cars are required to meet basic standards of street safety, but are not required to have any special racing modifications. The public is free to mingle with the cars in the staging and display areas, and rides are encouraged. These events are great places to get a first close contact with electric cars.

Events at race tracks are a little different. Generally, admission tickets allow spectators into the grandstands and display areas. You usually need another pass to get into the "paddock" where the race cars are garaged.

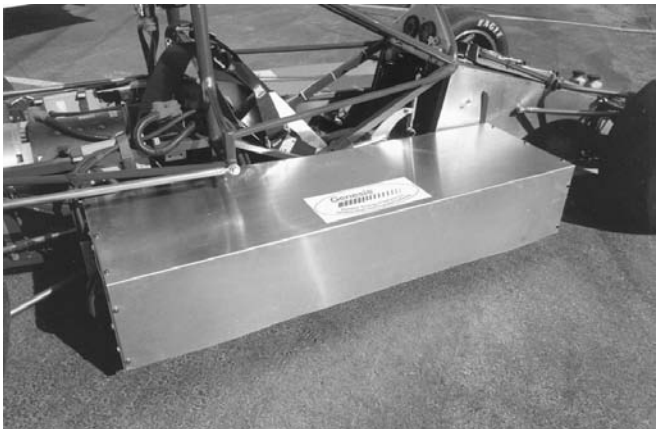
Access is further restricted in the "cold pits" and "hot pits". The cold pits are staging areas where teams

gather their tools and supplies for supporting the car during the race. They are separated from the hot pits by a low wall. The hot pit is the parking space the car will pull into during the race for quick charging, battery swaps, or repairs.

Due to the dangers from high speed traffic and working pit crews, the public is not allowed in the hot pits, and media passes give limited access to reporters and photographers. This area is even more dangerous in EV races than in conventional races. Although the speeds on the pit road are slower, the cars are silent and can sneak up on the unwary very quickly.

Safety First

Almost all racing events require some kind of inspection. Race track events have more detailed inspections known as "scrutineering". These inspections serve two purposes. The first, of course, is to be sure the car is safe. Inspectors will check for proper safety equipment, such as an onboard fire extinguisher and an emergency power disconnect device that is clearly marked and in reach of personnel outside the car. Batteries must be properly contained and secured.



Some classes of racing require substantial safety modifications to the cars. Roll cages are welded onto the frame. Small holes are left in non-critical areas so that inspectors can measure the thickness of the steel roll bar. On stock cars, headlights are taped off and side windows replaced with nets to minimize broken glass in case of a collision. Doors may be pinned or welded shut so they cannot fly open.

These cars don't have ordinary seatbelts and shoulder harnesses. Instead, they use a special racing harness that comes down snugly across both shoulders, across the waist, and up between the legs.

The driver is also inspected. He or she must have the proper license for that class of racing, a medical clearance, and suitable driving gear. This includes fire

resistant "long john" underwear made of Nomex, a racing jumpsuit, boots, gloves, and a helmet with face shield.

While the driving suit may look like it was designed to make the driver look snazzy, it was actually designed to protect him or her in a crash. The underwear and jumpsuit offer some padding and fire protection, but the

insulation can make it very hot inside. A driver in a long race at Phoenix may lose several pounds by perspiring. The helmet specifications are regularly upgraded. Older helmets may not meet requirements.

Electric cars require some inspections conventional race cars do not. For example, the charger has to pass muster for safety, including grounding, fusing, and internal circuit breakers. For this reason, home made chargers are not recommended and may not be allowed for some events.

Follow the Rules
The second purpose of the inspection is to ensure that the cars comply with the rules for their class and event. They may be restricted to lead acid batteries, a DC system, or a maximum voltage.

There may be minimum weight requirements within a class, such as Electrathon racing. Vehicles below the minimum (with driver) must carry ballast. In other classes there are maximum weight limits. For stock cars, these are usually tied to the car's original gross vehicle weight as specified by the manufacturer.

Qualifying for the Grid
The days before the race will be spent on practice and qualifying. The practice sessions allow drivers to become familiar with that particular track. Each track is different, sometimes in subtle but important ways.

In qualifying, each car will get a few laps to show its stuff and compete for position on the grid. The cars run one at a time with a lap or two for warm-up, one or more timed laps, and a final slow-down lap.

Just before race time, the cars will gather in a pre-grid area to get into their positions according to their qualifying times. Often they are set up in lines two or even three abreast. Sometimes the rules specify an inverted grid with the fastest qualifying cars starting at the rear of the pack to work their way forward.

The Race Is On
Almost all races (except drags) use a flying start. The cars make one or more laps in formation behind a pace car, building up speed. When the pack reaches the start/finish line, the flagman will wave the green flag to officially start the race. By this time, the pace car has peeled off into the pits.

I'd like to add a word here about course workers. The most visible one is the person at the start/finish line, but in fact, they are scattered all around the course. These are usually volunteers from the Sports Car Club of America.

Course workers are the communications net of the track. They have radios and can report any illegal or unsafe conditions that might not be visible at the start/finish line. These people tend to be very dedicated and professional. They help ensure the fairness and safety of the event, and are the first emergency personnel on scene in an accident.

Many drivers nowadays have radio contact with their pits. However, the track officials must communicate with them via course workers with flags and (on large professional tracks) lights. The lights are similar to stoplights and placed strategically around the track. They communicate the main three flag colors, green, yellow, and red, to the drivers instantly. There are also course workers at key points to wave colored flags.

Flags and Lights
The starting green flag and the ending checkered flag are waved at the start/finish line under the direction of race officials. However, other flags are flashed all along the course. Course workers may be directed by radio to wave a certain flag, or they may flag a situation on their own if they observe a hazard, which they then radio to the officials.

The green flag is easy, meaning "go like hell". It opens the race but it is also used to indicate the end of any hazard that may have put the track under caution.

The yellow flag is the "caution" flag. This comes out when there is an accident or debris on the track. It means that the race can continue, but at reduced speeds. No passing is allowed under caution, but the drivers may close the gap to the car ahead of them. Sometimes a pace car is brought out to lead the pack, and they regroup behind it. Rules vary about whether pit stops are allowed during cautions.

The red flag stops the race. This comes out when there is an accident, debris, or weather so severe that it is unsafe to continue. All cars are usually directed to the pits to wait it out. When the hazardous conditions are cleared, the race will be restarted with the cars gridding up in order behind the pace car.

This Means You
The red, yellow, and green flags fly for all the cars at the same time, all around the track. The black flag is pointed at one particular car. It means, "Go to the pits, you are in big trouble." Sometimes this means the driver broke a rule and is being forced to pit briefly or even to quit the race as punishment. However, it may also mean that someone has spotted a dangerous condition on the car, such as something loose or leaking.

Another flag pointed at a particular car is a blue flag with a yellow diagonal stripe. It means, "There is a faster car approaching behind you. Let it pass." If two

cars are running nearly the same speed, they will be allowed to battle for position. However, if one of the faster lead cars has overtaken a slower backmarker, the slow car will be instructed to let it pass. At this point, they aren't competing for the same position, and bottling up the faster car is unsafe.

Stripes & Checkerboards

A flag rarely seen at EV races is the one with alternating red and yellow vertical stripes. It means, "Watch out, the pavement is slippery here," usually from spilled oil. Whenever an accident causes spills of any kind on the track they are quickly covered by powdered absorbent and swept off. This is, of course, not much of an issue for EVs.

The second-to-last flag is the white flag. No, it doesn't mean the officials surrender. It means there is only one lap left. This is your last chance to make your move.

The final flag is the one everyone wants to see: the black-and-white checkered flag. Although everyone thinks of it as marking the winner, it actually marks the end of the race. It is waved for every car as it comes by. The winner simply gets to see it first—and take it home.

It Ain't Over Till It's Over

It isn't necessarily over when the checkered flag drops. It is possible for other teams to file a protest against the winner if they feel some rule was broken that gave an unfair advantage. There is a specific procedure for presenting the protest to officials for ruling. If there are charges relating to the hardware of the car itself, it may be impounded and even completely disassembled for examination. If the officials find irregularities they can disqualify the win or penalize the car to a lower position.

Success in racing involves more than just bringing home the trophies. There is prize money for several top positions, and there may be money for the fastest single lap, or most laps led, or other categories.

Also, there are points accrued throughout a racing season towards the championship. It is entirely possible for someone to win a championship without ever winning a race, just by being consistently second or third all season.

Next time, let's look at racing driving techniques and etiquette, and how they apply to electric cars.

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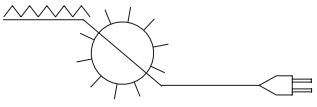

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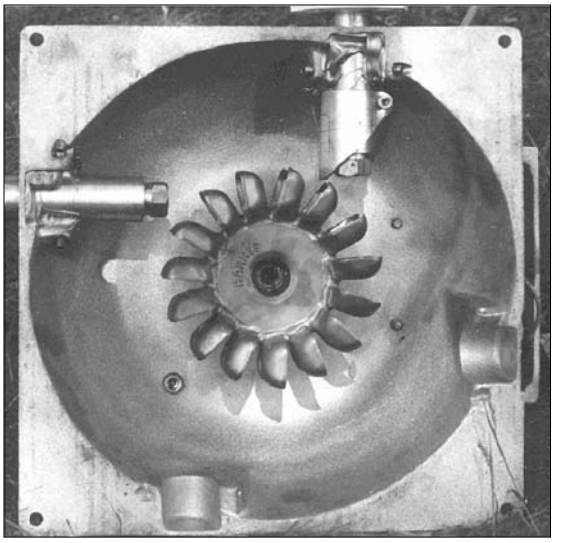

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Clean Up Your Energy

Steve McCrea

We who haven't yet disconnected from the grid can still do our part in reducing the emissions caused by our demand for electricity. Emissions of sulfur and carbon dioxides vary depending on what fuel is used by the electric power plants. Using Table 1 you can calculate the amount of SO_2 and CO_2 emitted to provide your power. Of particular interest to Go Power readers is how to offset the carbon and sulfur emissions of an electric vehicle that is charged by non-renewable generated electricity.

Per-kWh (kilowatt-hour) emissions of sulfur dioxide (SO_2) and carbon dioxide (CO_2) vary significantly depending on the fuel source. Table 1 shows that electricity from coal has almost twice the CO_2 emissions as that generated by natural gas. Most off grid systems allow a vehicle owner to charge batteries without emitting CO_2 or SO_2.

With utilities purchasing electricity from other utilities, it's very difficult to determine where your electricity comes from. Anyone connected to the grid will indirectly contribute to the formation of acid rain and global warming.

To estimate how much global warming that you and your household is responsible for, the EIA publishes a guide (Form EIA-1605) giving estimates for CO_2 emissions in pounds per kWh and tons per megaWatt-hour. Using the form's Appendix C, "Adjusted Electricity Emission Factors by State", an EV owner can calculate a vehicle's estimated contribution to greenhouse gas emissions. It is calculated here in Table 2.

Retiring Allowances

If you believe in the Law of Organizational Genesis (when a new problem is discovered, at least one new organization is spontaneously conceived), you won't be surprised to hear that there are non-profit groups waiting to help you clean up your indirect sulfur and carbon emissions. The National Healthy Air License Exchange (INHALE) in Cleveland, Ohio, aims to reduce SO_2 emissions by purchasing "allowances" or "permits to pollute" sold by the US Government at auction. In 1994, INHALE purchased enough permits to release 4 million pounds of SO_2 and the group has promised to retire these allowances. Groups of students primarily from secondary schools have also raised money to purchase and retire SO_2 allowances. Removal of carbon emissions can also be achieved by planting trees. A list of tree planting programs can be obtained by writing to the Global Cooling Action Center.

Table 2 gives the reader a state by state average emission rate per kWh for SO_2 and CO_2. The far right columns show the estimated cost for offsetting the emissions created by an EV. "Low EV Use" is for EVs driven 15 miles per day at 3 miles per kWh, typical for an off-highway EV traveling at speeds below 45 mph. "High EV Use" assumes greater acceleration and higher speeds resulting in lower efficiency (2 miles per kWh) and approximately 35 miles per day (11,000 miles per year, close to the US average of 11,400 miles for a two-vehicle household with children [1]). If your EV runs closer to the High EV Use, just multiply the cost figures by three.

Table 1. Comparisons of CO2 and SO2 by Selected Fuel Source

Fuel	*Carbon Dioxide*		*Sulfur Dioxide*	
	lbs per kWh	*Tons per 1000 kWh*	*Grams per kWh*	*lbs per 1000 kWh*
Coal	2.4	1.20	10.0	22.0
Fuel Oil	2.0	1.00	5.4	11.9
Natural Gas	1.3	0.65	0.0	0.0
National Weighted Average	1.5	0.75	5.8	12.8

Source: Power Page, "How Do We Measure Our Individual Contribution?", Nov 1993, US Environmental Protection Agency, EPA 430-F-93-017.

Note 1: Rocky Mountain Institute has calculated that hidden energy losses should make the national weighted average close to 1.9 lbs CO2 per kWh, rather than 1.5 lbs/kWhr.

Notes for Table 2 asst Right
Table 12 = EIA Electric Power Annual 1994 Volume I
Table 24 = EIA Electric Power Annual 1994 Volume II
[a] = Calculation by R. Heede, Rocky Mountain Institute
[b] = USEPA estimate, 1.5 pounds/kWH
[c] = use national average amount shown below (9 pounds of SO2/1000 kWhrs)
[d] = Figures show production in the state; actual electricity consumption may vary
** = less than 500 short tons. All tons = short tons (2000 lbs.)
—- = insufficient data
Low Electric Vehicle Use = 3 miles per kWhr, 5,500 miles per year Assume: 1833 kilowatt-hours used annually
High Electric Vehicle Use = 2 miles per kWhr, 11,000 miles per year Assume: 5,500 kWhr annually
To obtain costs for High Electric Vehicle Use, multiply cost columns by 3.

Table 2

State	Sulfur Dioxide per MWhr (pounds)	Carbon Dioxide per MWhr (tons)	LOW EV USE Pounds of SO2 made by low EV use	LOW EV USE Tons of CO2 made by low EV use	COST TO OFFSET EMISSIONS FOR LOW EV USE SO2 ($0.08/lb)	COST TO OFFSET EMISSIONS FOR LOW EV USE CO2 ($0.50/ton)	HIGH EV USE Pounds of SO2 made by high EV use	HIGH EV USE Tons of CO2 made by high EV use	Table 24 Sulfur Dioxide 1000 tons	Table 12 Electricity Million kWH Production [d]
New England	4.89		8.97		$0.72		26.91		198	80934
Conn.	1.84	0.358	3.37	0.66	$0.27	$0.33	10.11	1.97	25	27201
Maine	1.11	0.483	2.03	0.89	$0.16	$0.44	6.1	2.66	5	9016
Mass.	8.59	0.729	15.75	1.34	$1.26	$0.67	47.26	4.01	118	27466
New Hamp	8.41	0.426	15.42	0.78	$1.23	$0.39	46.27	2.34	50	11888
Rhode Is.	---	0.546	[c]	1	$1.32	$0.50		3	**	69
Vermont	---	0.08	[c]	0.15	$1.32	$0.07		0.44	**	5294
Mid Atlantic	9.21		16.89		$1.35		50.68		1404	304724
New Jersey	3.32	0.387	6.08	0.71	$0.49	$0.35	18.26	2.13	53	31932
New York	4.7	0.518	8.62	0.95	$0.69	$0.47	25.87	2.85	244	103763
Penn.	13.1	0.643	24.01	1.18	$1.92	$0.59	72.04	3.54	1107	169029
East North										
Central	17.31		31.72		$2.54		95.18		4356	503410
Illinois	11.31	0.433	20.73	0.79	$1.66	$0.40	62.21	2.38	779	137746
Indiana	22.65	1.086	41.52	1.99	$3.32	$1.00	124.58	5.97	1172	10348
Michigan	9.48	0.788	17.38	1.44	$1.39	$0.72	52.16	4.33	397	83721
Ohio	28.2	0.904	51.69	1.66	$4.13	$0.83	155.08	4.97	1819	129021
Wisconsin	7.65	0.671	14.02	1.23	$1.12	$0.61	42.05	3.69	189	49437
West North										
Central	9.3		17.04		$1.36		51.13		1072	230624
Iowa	10.76	0.843	19.73	1.55	$1.58	$0.77	59.19	4.64	172	31964
Kansas	3.81	0.852	6.98	1.56	$0.56	$0.78	20.95	4.69	71	37284
Minn.	4.3	0.814	7.88	1.49	$0.63	$0.75	23.66	4.48	88	40917
Missouri	16.45	0.891	30.15	1.63	$2.41	$0.82	90.48	4.9	506	61519
Nebraska	4.92	0.644	9.02	1.18	$0.72	$0.59	27.07	3.54	54	21946
N Dakota	10.21	1.151	18.71	2.11	$1.50	$1.05	56.13	6.33	148	29004
S Dakota	8.26	0.456	15.14	0.84	$1.21	$0.42	45.43	2.51	33	7991
S. Atlantic	9.99		18.31		$1.46		54.95		2943	589168
Delaware	10.12	0.928	18.54	1.7	$1.48	$0.85	55.64	5.1	43	8501
DC	14.6	1.324	26.76	2.43	$2.14	$1.21	80.29	7.28	2	274
Florida	9.79	0.647	17.94	1.19	$1.44	$0.59	53.84	3.56	694	141791
Georgia	11.2	0.61	20.53	1.12	$1.64	$0.56	61.6	3.36	553	98753
Maryland	11.38	0.678	20.86	1.24	$1.67	$0.62	62.58	3.73	249	43766
N Carolina	7.92	0.675	14.51	1.24	$1.16	$0.62	43.54	3.71	362	91455
S Carolina	5.07	0.344	9.29	0.63	$0.74	$0.32	27.87	1.89	188	74194
Virginia	6.52	0.554	11.96	1.02	$0.96	$0.51	35.88	3.05	172	52732
W Virginia	17.5	1.003	32.08	1.84	$2.57	$0.92	96.26	5.52	680	77703
E South										
Central	12.81		23.49		$1.88		70.47		1796	280344
Alabama	10.76	0.684	19.72	1.25	$1.58	$0.63	59.18	3.76	512	95171
Kentucky	16.29	0.965	29.86	1.77	$2.39	$0.88	89.6	5.31	685	84097
Mississippi	7.02	0.537	12.86	0.98	$1.03	$0.49	38.59	2.95	92	26222
Tennessee	13.55	0.668	24.83	1.22	$1.99	$0.61	74.51	3.67	507	74854
West South										
Central	3.76		6.9		$0.55		20.7		753	400239
Arkansas	3.44	0.643	6.3	1.18	$0.50	$0.59	18.91	3.54	68	39548
Louisiana	4.02	0.694	7.37	1.27	$0.59	$0.64	22.12	3.82	121	60170
Oklahoma	4.05	0.836	7.43	1.53	$0.59	$0.77	22.3	4.6	92	45381
Texas	3.69	0.776	6.77	1.42	$0.54	$0.71	20.31	4.27	471	255141
Mountain	3.62		6.63		$0.53		19.89		477	263866
Arizona	3.84	0.399	7.04	0.73	$0.56	$0.37	21.14	2.19	137	71294
Colorado	5.28	1	9.68	1.83	$0.77	$0.92	29.05	5.5	88	33324
Idaho	---	0.134	[c]	0.25	$1.32	$0.12	0	0.74	**	7303
Montana	1.7	0.777	3.12	1.42	$0.25	$0.71	9.35	4.27	21	24705
Nevada	5.17	0.937	9.47	1.72	$0.76	$0.86	28.41	5.15	53	20519
New Mexico	4.2	0.703	7.69	1.29	$0.62	$0.64	23.09	3.87	63	30018
Utah	1.68	0.995	3.09	1.82	$0.25	$0.91	9.26	5.47	29	34455
Wyoming	4.02	1.097	7.36	2.01	$0.59	$1.01	22.08	6.03	85	42337
Pacific	0.82		1.5		$0.12		4.49		105	257404
Alaska	0.42	0.016	0.77	0.03	$0.06	$0.01	2.31	0.09	1	4762
California	0.06	0.378	0.12	0.69	$0.01	$0.35	0.35	2.08	4	126749
Hawaii	5.95	0.757	10.9	1.39	$0.87	$0.69	32.7	4.16	18	6055
Oregon	0.75	0.118	1.37	0.22	$0.11	$0.11	4.11	0.65	14	37490
Washington	1.63	0.153	2.98	0.28	$0.24	$0.14	8.95	0.84	67	82348
US Average	9	0.95 [b]	16.5	1.74	$1.32	$0.87	49.52	5.23	13104	2910712
		0.75 [a]		1.37		$0.69		4.13		

To estimate sulfur and carbon emissions for your electric bill, multiply the first two numbers in the row next to your state's name by the number of thousand kWh that your home consumes. If you used 1500 kWh last month and you live in South Dakota, you multiply 1.5 by 8.26 to get 12.39 pounds of SO_2 and 1.5 by 0.456 to get 0.912 tons of CO_2.

Observations

1. These figures are averages. The CO_2 column was supplied by EIA. The figures in the SO_2 column were arrived at by dividing the amount of SO_2 emitted by power plants in the state by the total electricity generated in the state. SO_2 from electricity that is generated outside the state is not included in a particular state's SO_2 value. California derives significant portions of its electricity from coal-powered plants in neighboring states, but SO_2 value for California (0.06 pounds per kWh) is less than one percent of the national average (9 pounds per thousand kWh)

2. Since your local utility may purchase electricity from a power plant in another state, your individual contribution to acid rain and global warming may be higher or lower than estimated in this table.

3. Idaho reports no SO_2 (electricity generated within the state comes from hydroelectric). New Hampshire and Vermont report less than 500 tons of SO_2 per year. Rhode Island reports generating only 60 million kWh, while the state's customers used 6,572 million kWhrs in 1994.

How To Reduce SO_2 and CO_2 Emissions

a. Use less electricity (always a good idea). As the t-shirt recommends, "Live Simply So That Others May Simply Live."

b. Switch to renewable energy sources.

c. Move to a state that uses less coal and oil and more renewable energy sources. (ed. note: As utility deregulation laws come into being, customers will be able to choose electricity sources that use renewable energy.)

d. Pay to pollute. The electricity user can purchase SO_2 emission credits (allowances) and sponsor the planting of trees to absorb CO_2 emitted by the utilities.

Grid users who live in states that generate less than 9 pounds of SO_2 per thousand kWhrs (the average rate of pollution for power plants in the U.S.) might consider paying at the national average, since some of your electricity might come from neighboring states. At 8 cents per pound, the allowance needed to retire 9 pounds of SO_2 per million Watt-hours of electricity amounts to 72 cents.

Doing Your Part

In October 1993, the Clinton administration issued its "Climate Change Action Plan" to respond to the threat of global warming. The initiative is based on a series of voluntary reductions for greenhouse gas emissions. Under the plan's "Forestry Actions," Action #44 seeks to "accelerate tree planting in nonindustrial private forests." [2]

To achieve the goal of reducing carbon emissions below the 1990 level by the year 2000, as stated by President Clinton on April 21, 1993, stronger measures than tree planting will be needed. In a speech given in Geneva, Under Secretary for Global Affairs Tim Wirth stated that the U.S. is "committed to ensuring that all countries take steps to limit emissions." He endorsed "the adoption of a realistic but binding target, leaving it to individual governments to decide the most appropriate measures needed to meet the agreed target." [3]

A BTU tax or a per-gallon tax to discourage fuel consumption, more vigorous energy-efficiency measures (funded by a fuel tax), and voluntary measures (tree-planting, telecommuting, carpooling, etc.) are some possible developments in the evolution of U.S. policy toward greenhouse gas emissions and climate change. But who can expect these ideas to gain popularity in our current political climate?

Instead of waiting for the U.S. and nearly 200 nations to agree on carbon reductions (and for Congress to adopt new taxes), you can do your part now. Begin to reduce not only CO_2 but also sulfur emissions by taking the voluntary measures suggested above.

Access

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The source for SO_2 emissions in 1994 was Table 24, "Estimated Emission from Fossil-Fueled Steam-Electric Generating Units at U.S. Electric Utilities by Census Division and State," which appears in Electric Power Annual 1994 Volume II, EIA-0348(94)/2, published by the Energy Information Administration. The data for the amounts of electricity came from Table 12, "Net Generation from U.S. Electric Utilities by Selected Prime Mover, Census Division and State," in Electric Power Annual 1, EIA-0348(94)/1.

INHALE, the National Healthy Air License Exchange, Box 14148, Cleveland, OH 44114, • 216-523-1111. Information about SO_2 emission allowance credits is available from INHALE. Cost is currently $8 per 100 pounds of SO_2.

Trees For The Future (TFTF), Global Cooling Action Campaign, Box 1786, Silver Spring, MD 20915 • 301-929-0238 • e-mail: TreesFTF@aol.com. A tree planting charity, TFTF has established the Global Cooling Action Center, which distributes a list of tree planting programs. Cost to sponsor trees: 50 cents per tree (tropical trees) to $10 per tree (a tree planting program in Oregon called Friends of Trees).

Notes

[1] Table 4.4, page 4-6, "Average Number of Vehicles and Vehicle Travel per Household, 1991 RTECS," Transportation Energy Data Book, Edition 15, edited by Stacey Davis, published by the U.S. Department of Energy.

[2] Pages 48-49, "The Climate Change Action Plan," October 1993. By 1997, the US Department of Agriculture will increase grants to stimulate tree planting in existing nonindustrial private forest land by an additional 233,000 acres. Tree planting under USDA cost-share programs is currently 435,000 acres per year. "This action reduces greenhouse gas emissions from projected 2000 levels by 0.5 million tons of carbon equivalent. Reductions associated with this initiative will be most visible in the years after 2015 due to the rate of carbon sequestration over a tree's lifetime."

[3] Timothy E. Wirth, "Statement to the Second Conference of the Parties Framework," Convention on Climate Change, Geneva, Switzerland, July 17, 1996.

Electro-Biking

Homebrew

Bill Gerosa, Jr.

The northeastern portion of the United States is not particularly kind to avid cyclists, especially those who work during prime daylight hours. The electro-bike, herein referred to as E.B., was designed to keep the user aerobically fit while creating some extra power to charge batteries.

Any bicycle will do. However, bicycles with wheels of larger diameters, such as 27 inches as opposed to 16 inches, create more mechanical advantage as will be shown. Both street bikes, with very narrow, smooth tires, and mountain bikes, with wide, knobby tires, have been used with equal success. The bicycle is placed upon the stand, which is an Advent Mag-Trainer. It comes assembled and folds up easily for transport—even after the generator is added.

Construction

First, we removed the roller and flywheel mechanism from the Advent Mag-Trainer's frame. Two nuts and bolts hold the roller in place. Then, a metal plate, with two holes drilled in it, was placed upon the bike stand's swivel mount, right under the rear wheel of the bike. This plate was 11 inches by 7 inches and stiff enough to allow slight flexing. Two nuts and bolts were used to secure the plate to the swivel mount. The generator was mounted upon this plate using four, two inch L brackets. There are two long bolts that run through the generator, horizontally when the generator is on its side. The L brackets can simply be fastened to these.

It is not feasible to have the axle of the generator pressed up against the bike's rear wheel because massive slippage occurs. A small wheel needs to be fastened to the generator's axle. Anything with a circumference between 2 and 10 inches should do. The smaller the wheel, the greater the mechanical advantage, but the more likely slippage is. I simply used the flywheel that came with the stand. Since the generator's axle was too large to be fastened to the flywheel, I had to grind the axle down. Hooking the

generator to a 12 Volt battery and running it as a motor allowed the use of a file to whittle down the axle to the proper size. Once this was accomplished, we put the flywheel on the generator and drilled a hole through the flywheel mount and generator's axle to get a secure fit. A bolt was passed through this hole and fastened with a lock washer and nut.

Operation

The bicycle is secured upon the stand by placing the E.B.'s back wheel between the Advent stand's two cup holders. A cycle's rear wheel has an axle with a lug nut at each end. These lug nuts are to be placed in each one of the cup holders. Then the cup holders are to be tightened down on the lug nuts until the bicycle is held firmly. This also allows perfect alignment (left to right) of the rear wheel directly above the generator's wheel. Now the tension of the generator mount needs to be set. The knob under the metal plate changes the inclination of this plate upon which the generator is mounted. The adjustment knob should be tightened so that you can hold the generator's wheel with one hand while trying to spin the bike's rear wheel with the other and get no slippage. Do not overtighten. This will put undue stress on the components. It does not take much tension to eliminate slippage.

Since the rear wheel of the bike is about one inch off the ground while in the stand, place a piece of wood under the front wheel. This will make the bike level and prevent the rider from sliding forward on the seat while pedaling. Keep in mind that the folks at Advent constructed this stand so that you may easily remove a fully functional road bike and take it out for a spin on a sunny day. Simply unscrew the holder cups from the lug nuts of the E.B. and the bike easily comes away from the stand.

Math and Mechanics

The Univega Mountain Bike we used for most of the testing has 26 inch wheels. The circumference is approximately 82 inches (Circ. = PI * Dia. or 3.14 * 26 =

81.64). This fact is important when deciding on the wheel you are going to use on the generator. A wheel with a circumference of 10 inches will spin 8.2 times faster than the bike's rear wheel (82/10 = 8.2). A wheel with a circumference of 4 inches yields much more mechanical advantage (82/4 = 20.5 times). The faster the generator's axle spins, the more amperage is available at the generator's output terminals.

I had no way of accurately measuring work exerted on the bike, but I tend to spin a bike's cranks at about 80 RPM using the large sprocket when I am on the road. This large, front sprocket has 52 teeth and the smaller sprocket on the rear wheel has 13 teeth, meaning the rear wheel spins 4 times faster than the cranks do. If the cranks are spinning at 80 RPM, then the rear wheel is spinning at about 320 RPM. As shown before, the rear wheel has a circumference of 82 inches to the flywheel's 10 inches. The generator's axle spins 8.2 times faster than the rear wheel. So, the rear wheel moving at 320 RPM means that the generator's axle is spinning at about 2,624 RPM.

This generator speed consistently creates about 4 to 5 amperes of power. Crank speeds closer to 100 RPM create about 6 amps. On sprints, I have watched the ammeter jump to almost 7 amps, but these speeds are not sustainable, even for the disciplined athlete. The amperage measurements were obtained by hooking an ammeter directly to the generator. Use blocking diodes (I suggest at least 10 ampere diodes) between the generator and the battery to prevent the generator consuming power when it is not in use.

The Next Step

Recently, we have added a second generator to the stand which doubles the power output. I am searching for a larger generator that would do the work of two American Bosch generators. Please note, that although I have listed the supply house for the American Bosch generator, they no longer list this item in their catalog. I believe they still have some in stock, though.

All of this experimentation is a fine balance between power creation and the strength required to turn the bike's rear wheel. The current configuration with one American Bosch generator can be easily spun by people of all ages. Larger generators would be more difficult to spin and might be feasible only for those looking to endlessly climb imaginary hills.

Finally, a cyclocomputer will be added that will measure ground speed, time in training, average speed and top speed. This instrument will be used primarily to compare the E.B. feel to that of a bike on a road surface. If the average speed of the E.B. is much higher than that of the bike on the road for a trip of the same length, then it can be deduced that the E.B. is "too easy" and more load should be mated to the E.B.'s rear wheel. Since there is no wind present when using the E.B. indoors, additional resistance must be presented to the E.B.'s rear wheel to experience a life-like ride.

System Cost

The Advent Mag-Trainer was purchased at a cost of $140 plus tax at the local bike shop. The American Bosch generators were $12.95 apiece. All the other hardware, which we already had in the basement, would have only been a few extra dollars to purchase.

Access

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Advent Mag-Trainer procured at local bike store

American Bosch generator (Item# 10-1023) Supplier: Surplus Center, 1015 West "O" Street, P.O. Box 82209, Lincoln, NE 68501-2209 • 800-488-3407

Rubber Meets the Road

Don Loweburg

Pacific Gas & Electric drags their Feet

Last issue I mentioned Dave in Central California. He had connected his code approved sinewave PV power plant to the Pacific Gas and Electric (the local utility) system and notified their business office that he was taking advantage of the new California Net Metering law. Now for the rest of the story. About a month later a field engineer visited Dave's home and inspected the system. Dave was on vacation at the time but the meter spinning backwards confirmed to the engineer that generation was taking place. The engineer removed Dave's meter in order to check for a safety shut down feature. All properly installed and qualified inverters must do this.

Being satisfied that the system was safe, the engineer replaced the meter and left Dave a phone message stating that he had an illegal installation and that he was about to be served with a five day disconnect notice! Dave called me from the road and I in turn contacted the field engineer. He agreed not to do anything till Dave got back and we scheduled a meeting. At that meeting five PG&E personnel were present. Dave gave them a full tour of the system. Inverter documentation was provided and they were made aware that the system was code compliant and inspected.

All agreed that it was a clean, safe system. The engineer who had originally removed the meter for testing purposes said that he would not have replaced it if he thought the system unsafe. However, because a special type of switch (visible, lockable) was not present, Dave was presented with a five day disconnect letter. Basically the deal was "do it our way or else". Now Dave is a very reasonable person. But with a career background as a senior television broadcast engineer he is not used to being pushed around. After some heated words the letter was withdrawn and we all agreed to meet again in one week. Dave's PV system remained grid connected.

At the next meeting four utility personnel were present. The issue again centered on the type disconnect. Our position is this: the inverter has approved automatic grid disconnect when the utility power goes out; the inverter can be isolated from the system using its own dedicated breaker on the main panel; further protection is gained by disconnecting the main breaker and for final assurance the meter can be removed. (Recall this is the disconnect means of choice when the utility wants to discontinue your service and it is visible and lockable!). I count four fold redundancy here. Any one of which protects the service person. Also don't forget that it is a universal procedure to ground the lines at the pole when a service person is working on the line. Dave's system and any installed like it (to NEC standards) are safe! The Simplified Net Metering Interconnection (SNMI) like Dave's is approved by Southern California Edison. We propose that it be acceptable nationwide for all net metering installations. The SNMI was worked out by the California PV collaborative which included IPP, Cal Seia, CEC (California Energy Commission), representatives of manufacturers, distributors, Southern California Edison, and others. It is being used as such by Southern California Edison in its PV grid connected program approved by the California Public Utilities Commission. (SCE just gave the green light to a privately owned, PV/grid-intertied restaurant. The system was installed by IPP member Chris Prelitz of Native Sol. At the final inspection Edison engineers stated that removing their service meter would serve as a lockable disconnect.) If it is good enough for SCE it should be good enough for PG&E. PG&E is applying a standard dated from the 1970s that is appropriate to commercial installations (It's their Rule 21 covering QFs and parallel generation) but not for the uniquely legislated Net Metering installations. The outcome of the meeting was that PG&E gave Dave the ultimatum; discontinue net metering or lose service. Dave's system is now stand alone for the time being. Dave will file a formal protest with the California Public Utilities Commission. Thank you Dave for being a true PV Pioneer. We hope that by the time this issue of Home Power is out this will have been resolved.

And Kicks and Screams

It looks like there will be battle in the trenches in order to get net metering implemented. Recall the three weapons mentioned last issue that utilities use to impede customer access to the grid: legislative, tariffs,

technical and safety requirements. PG&E has used all three. They opposed, and to some extent, gutted net metering in the California legislature. After the law passed, they imposed tariffs on Net Metering (removing them only after extreme protest). Currently they are imposing unnecessary safety requirements that increase cost to the customer. PG&E customers need to be asking, "Why?"

New York News

The following report is submitted by James Corrigan.(See access)

"On October 23rd, Governor Pataki of New York vetoed the State's Net Metering law which had been passed by the State Legislature in early July. The legislation would have allowed residential homeowners to intertie photovoltaic systems of 10 KW capacity or less to the utility grid using a single non-time differentiated meter. It also ensured that the utility could not differentiate between independent power producers and other residential customers by charging different rates or through the addition of other charges or fees. Residential solar generation customers were to receive full credit for each KWH of electricity that they produced, netted against their consumption. They would be credited for any excess power that they produced which would be carried from one billing period to the next. At the end of each annual billing cycle any unused credit would be purchased by the utility at its avoided cost which varies from utility to utility. The law also required that all photovoltaic systems meet all applicable safety and power quality standards established by the National Electrical Code and Underwriters Laboratories.

The Net Metering legislation was in trouble almost as soon as it was passed by the Legislature, with the utilities bringing all the pressure they could bear on the Governor to veto it, citing safety hazards created by operating photovoltaic systems interconnected to the grid when it was down and calling the full credit provisions of the bill a subsidy to the residential generators from the other ratepayers. Governor Pataki used the safety issue as his justification for vetoing the legislation even though he and his staff were fully informed of the adequacy of the National Electrical Code safety requirements and the favorable experiences of utilities in those states which have Net Metering laws, such as California and Massachusetts.

The Long Island Center for Independent Energy Living (LI-CIEL), which had been formed in anticipation of the passage of the Net Metering law to foster the widespread use of renewable energy systems on Long Island, working in conjunction with the Sierra Club and a number of other small environmental organizations, performed a massive automated calling campaign to alert environmentalists in the State that the Governor had the bill and was succumbing to utility pressure. By the second day after the Governor had received the bill, the LI-CIEL had reached over 22,000 activists. The Governor's office was flooded with calls, but unfortunately, he did not respond to the pressure.

A Hard Lesson Learned

The big mistake made in the campaign to enable Net Metering in New York was that the electrical workers' unions were not engaged by the originators of the bill. Locals such as the IBEW #1049 which covers the utility workers of the Long Island Lighting Company (LILCO) were unaware of the specific provisions of the law and were not exposed to the safety experiences of utilities in those states that have net metering. Instead, they accepted information given them by the utilities and took an adversary role regarding the legislation.

The law is now being redrafted by the National Resources Defense Council and the Sierra Club. Members of the LI-CIEL have already initiated discussions with IBEW Local 1049. While the Net Metering bill would have required utilities to allow net metering, there is nothing stopping LILCO, the IBEW, and members of the local renewable energy community from sitting down and designing a program that works to everyone's advantage."

Ashland Oregon Adopts Net Metering Plus

On October 2, 1996 Catherine Golden, Mayor of Ashland, Oregon signed a resolution adopting a "Renewal(sic) Resource Purchase Policy For the City of Ashland". The resolution states, "This policy is designed to provide adequate incentives to encourage renewable generation while remaining on the city's electric grid". The policy dictates a single bi-directional meter (Net Metering). As an extra incentive, the city will pay 1.25 times highest residential base rate for the first 1,000 KWH of excess generation each month. Both wind and PV sources are eligible and customers may be either residential or commercial. (These were gutted from the California Net Metering law). Congratulations both to the residents and the city officials of Ashland.

California PV Collaborative and Restructuring

The California Renewables Working Group is history. With the passage of AB 1890 the California Legislature took over the restructuring process from the California Public Utilities Commission who had originated it. This represents a back door coup by California utilities. Gene Coyle, Energy Analyst for California based TURN (Toward Utility Rate Normalization), a consumer advocates group, reports over $1.5 million utility money was spent lobbying for AB 1890. The key feature of the bill is a bail out of all utility "stranded assets" (primarily

nukes). The mechanism will be a non bypassable transition charge to all customers coupled with a state bond. Other features include phased direct access and the evolution of a competitive generation market.

During the phased transition of the next four years, about $500 million is earmarked for renewables. This in my mind constitutes token crumbs. (Keep in mind utilities are receiving billions of bailout dollars.) Of this perhaps $100 million will be for solar and PV. The California Collaborative will be focussing on what the best use of these resources are. Activities being considered are: financing, market incentives such as buy downs, and rate based incentives.

IPP has at times been termed adversarial with respect to utilities. Developments towards utility restructuring nationally have strongly confirmed our position. We are the competition-or they are-depending on how you look at it. Everywhere I read utility comments to the effect that they plan to move into new markets once restructured. What are these markets? Broadly defined these are called Energy Services. Among these services are: off-grid renewables, hot water, demand side management, energy efficiency, energy and load audits, and distributed PV generation (grid-connected). In the past these services have been offered by companies loosely referred to as Alternative Energy. Now, well capitalized companies calling themselves Energy Service Companies (ESC) are being created. Utilities will create affiliate companies along the ESC model and compete in this market. One of the wrinkles that will strongly affect IPPs is that these ESCs can work outside of their usual service areas. Thus S. CA Edisons's ESC can work PG&E's turf and vice-versa. This nasty little "workaround" will bypass PUC rules designed to keep the utility monopolies from walling out competition from other providers.

IPP business members, of course, are in this market right now. It is important for us to exercise good business sense and understand the competition. No organization has addressed these issues other than IPP. The Solar Energy Industries Association and its state chapters have in large part, been dominated by manufacturing interests. Unfortunately, many manufacturers have been very aggressively courting the utility market and have expended little effort towards and had little faith in the end-user market. We are on our own. From this perspective, it should be understandable why IPP looks so disfavorably on federal subsidies to UPVG (a utility PV consortium) and state mandated bailouts that reward poor utility business choices (building nuclear power plants).

IPP's mission is to represent the renewable energy service provider and their customers, help shape policy choices that encourage continuing market growth driven by end-user demand, develop and support a professional infrastructure, and provide a forum for discussion of the issues around renewable energy use. IPP welcomes new membership (business or individual). Look for the IPP logo. Keeping IPP members in business is the strongest defense we have against utility domination and eventual monopoly of renewable energy.

Other bits and pieces

Booming rooftop PV programs in Germany and Japan may soon create a module crunch in the US. In Japan the government is assisting home owners who wish to purchase roof top PV. A limited program begun 2 years ago has expanded into a multi-megawatt program with customers on waiting lists. In Germany RBI (Rate Based Incentive) programs are exploding. By the end of this year customer owned rooftop PV will exceed 5 megawatts. PV demand created by these end-user targeted programs coupled with increasing international demand is creating a shortage of modules and may affect availability in the US.

More Gridmen Cometh

More utilities enter offgrid market. From a press release dated October 14, 1996, Austin, Texas: "Solar electricity for utility customers in Texas could become an affordable commercial reality thanks to a new coalition of Texas based rural and municipal electric utilities. The Texas PV Coalition (TxPVC) has been formed to accelerate the commercial availability of photovoltaic (PV) systems as a service alternative to extending utility lines.

TxPVC has received initial funding from the Utility Photovoltaic Group (UPVG), a national organization of 90 utilities funded by the U. S. Department of Energy. TxPVC will also be working in close collaboration with Photovoltaic Services Network (PSN)" We discussed PSN several issues back but, you guessed it, they too are subsidized by DOE.

Colorado Sunsevices Solar PV-VALUE System may be an opportunity to own a PV system at reduced cost. A limited number of rooftop PV systems will be offered to Colorado utility customers. System "buy down" will enable PV systems to be purchased for about $4/watt. If interested contact: Mandy Herner, Colorado Public Service Co. at 303-571-7243

Access

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Listing PV Equipment

John Wiles

All manufacturers of PV equipment, both large and small, should consider having that equipment listed to standards established by Underwriters Laboratories (UL). The benefits of marketing listed equipment are numerous and were pointed out in the Code Corner Column in Home Power Magazine Issue 55. This column will present some of the finer points of the relationship between the National Electrical Code and listed equipment, and how the testing and listing laboratories do business.

NEC Requires Listed Equipment

The National Electrical Code (NEC) establishes a set of safety requirements for electrical power systems that are installed in residential, commercial, and industrial locations. The NEC does not cover mobile installations (except RVs and house boats), nor does it cover installations owned and operated by utility companies on their own property used exclusively for the generation, transmission, and distribution of electrical power.

The NEC is published and updated every three years by the National Fire Protection Association. The most recent edition is the 1996 NEC. It is a safety and fire code that is nearly 100 years old and is the most comprehensive electrical code in the world.

The National Electrical Code is a model electrical code that has been legislated into law in at least forty states and most major municipalities throughout the United States. Local codes may be mandated that supplement the NEC and each jurisdiction may be using a version of the NEC that is not the most recent version.

The NEC requires that all equipment that is installed under the code be examined for safety. The authority having jurisdiction (AHJ), usually an electrical inspector, is the person that makes this examination. To relieve the AHJ from having the extensive knowledge, test equipment, and experience to test and evaluate each and every component and piece of electrical equipment, a process of listing and labeling is used.

Listing and labeling is a process where an independent testing laboratory (recognized by the AHJ) tests and evaluates, in a rigorous manner, equipment and components against a set of detailed safety standards published by UL. The UL Standards are written to harmonize with the requirements of the NEC so that listed equipment will be reasonably safe and protect the user and associated property.

The listing and labeling of equipment provides the examination for safety required by the NEC and exempts the AHJ from inspecting each piece of equipment. The AHJ can then elect to accept the listing and labeling information as an indication that the particular equipment, when installed following the labeling and any instructions that accompany the product, will meet the overall safety requirements of the NEC.

Nearly every component in a conventional electrical system is listed and/or labeled. Listed items include: outlet cover plates, receptacles, switches, cables, wires, lamp holders, transformers, switchgear, disconnects, load centers, overcurrent devices, etc.

In residential, commercial, and industrial installations, the NEC deals with the electrical power system from the utility meter socket or point of service interconnection to the receptacle outlet or lamp holder. It also covers other types of electrical installations such as radio frequency systems, computer data installations, photovoltaic power systems, and a number of other electrical systems that may or may not be connected to a utility-provided source of electrical power.

End Use Appliances

End-use appliances such as vacuum cleaners, computers, table lamps and the like are not covered by the NEC. However, most of these devices that are sold in the U.S. are tested to appropriate UL Standards and are so marked. This ensures that the device can be used safely when connected to an electrical system that meets the NEC.

The Electrical System

When an electrical system is composed of listed components, installed in accordance with the requirements of the NEC, and inspected by the AHJ, there is a high probability that the system will be safe to use, operate, and maintain.

If the electrical system consists of a combination of listed and unlisted components and equipment, the AHJ has several options: examine the unlisted equipment for safety; require that the unlisted equipment be replaced with listed equipment where available; require that the unlisted equipment or even the entire system be examined by a qualified authority such as a testing laboratory or a Professional Engineer; or, refuse to accept the system.

Normally, complete electrical power systems are not listed. Complete systems are composed of listed equipment and components that are installed in accordance with the requirements of the NEC by a licensed electrician or electrical contractor and then inspected by the AHJ. Almost any system that requires separate and distinct components connected together with field-installed wiring falls into this category. For example, the electrical system in a building is installed in this manner.

A billboard lighting system is installed the same way. Listed lamp holders are connected with listed cable to a listed transformer, and are controlled and protected by listed switchgear and overcurrent devices. The wiring is field installed and inspected by the AHJ. Installations such as this are, by far, the most common. There has never been any intent in the NEC or local codes to list the entire system. To do so would require that all of the infinite number of possible combinations of components be tested separately and in combinations. In such a system, field-installed wiring would not be possible unless listed wiring harnesses with plug-in connectors were used. The costs in terms of time, testing laboratory capabilities, and funding make such a task nearly impossible, if not ludicrous.

Underwriters Laboratories will certify certain organizations to assemble subsystems like panel boards from UL-Listed components. These devices might include listed circuit breakers, listed relays or contactors, listed cables, listed connectors and similar items. The end item is not a system, but is certainly more complex than a single piece of listed equipment.

Small Listed Devices

There are categories of small, self-contained electrical power systems that are listed because they are more like end-use appliances than electrical power systems. An example might be the small emergency lighting system required in commercial buildings. Such a lighting system consists of two lamps, a battery, a charger, and a control system. The system is factory assembled, tested as a unit at the factory, tested by the testing lab during the listing process, and then just mounted on the wall and plugged in. There is no field-installed wiring and no requirement for inspection by the AHJ, although the local building inspector might inspect it for proper operation and placement.

Another example is the self-contained uninterruptible power supply (UPS) used for desk-top computers. As before, it is factory wired, listed, and plugged in. No AHJ inspection is required. Larger UPS systems can require field wiring with rooms of batteries and controllers that would require installation meeting NEC requirements and inspection by an AHJ.

A third example might be the solar-power path light which has a battery, a photovoltaic power source, and a light. It is factory assembled, listed by the manufacturer (if desired and sometimes required by local law), and inserted in the ground.

Photovoltaic (PV) electrical power systems are covered in the NEC in Article 690. Where Article 690 is in conflict with any other article in the NEC, Article 690 prevails because of some of the unique safety aspects of PV systems and the organization of the NEC. Most PV systems are installed using separate components and field-installed wiring and fall under the NEC.

The solar-powered path light, solar-powered calculators, and wrist watches are examples of items that would not fall under the NEC. However, in general, most PV systems, because they have an infinite number of possible component combinations, like all other electrical power systems, do fall under the NEC.

Any PV system, whether listed as an entire system, or installed in accordance with the NEC and inspected, should comply with the basic safety requirements of NEC Article 690 and the applicable UL Standards. These dual requirements are necessary because of the unique electrical characteristics associated with PV modules as power sources and with batteries as energy storage devices.

It is entirely possible to design a PV-powered system (such as a single-pole lighting system) complete from PV module to load, have the entire system factory assembled, and shipped to the field where it is turned on without any requirement for field wiring or assembly. Such a system could be listed as a unit by a qualified testing laboratory to UL Standards. For larger, complex systems, this is generally not done for the following reasons.

Listing means that the product, as evaluated by the testing house, meets the applicable requirements of the published standards at the time it is manufactured. Follow-up inspections and production line tests are required to maintain the authorization to apply the listing marks of the testing organization to the product. All product variations must be covered in the inspection

documents and changes cleared with the testing organization.

This process would be somewhat expensive for complex systems and, because of the vast number of possible combinations of electrical components and equipment, most electrical power system installers choose to use listed components, install them to the requirements of the NEC, and then have that installation inspected by the AHJ.

There is no history that establishes that a totally listed electrical power system is any safer than a similar system using listed components installed to meet the requirements of the NEC and then inspected by an AHJ. In fact, there are few, if any, examples of similar systems that are done both ways. Factory assembly of a system can usually be done under more carefully controlled conditions than a field assembly. On the other hand, a final inspection by the AHJ of a field-installed unit verifies that the system and components have not been damaged in shipping. The AHJ may also verify that the system being inspected has been installed properly and operates safely.

The UL Standards and the NEC are developed in close harmony by a group of professionals that include persons from the electrical equipment industries, government agencies, electrical inspectors, universities, and end users. The UL Standards are designed to be used with the NEC and visa versa. Electrical safety is the goal and it is being achieved in the United States on a daily basis.

How to Work With a Listing Laboratory

An applicant for a product listing writes a letter to one of the testing laboratories (see access). The letter should contain as much detail as possible about the product and the intended uses of the product. Full diagrams, mechanical details, lists of materials, schematics, manuals, alternate materials that may be used, photographs, and identification of listed and recognized components are minimum requirements.

The testing laboratory evaluates the materials submitted and prepares a plan for testing and a cost estimate. These are returned to the applicant along with an agreement for Follow-Up Service. The testing lab also determines the number of samples that will be required for the evaluation.

If the applicant desires to have the product listed, a preliminary deposit is sent to the testing lab along with the signed Follow-Up Service Agreement and the number of product samples required for the test.

In some cases, the testing lab may observe or validate testing that the manufacturer does, but in many cases the testing lab performs or contracts all of the required testing. A determination is made as to whether or not the product meets the required standards, and a letter is sent to the applicant stating any deficiencies.

The applicant makes the necessary corrections and resubmits the product.

When the tests show that the product is acceptable, the testing laboratory issues a final test report and a notice of product listing. The Follow-Up Services field representative visits the factory to verify that the products being manufactured are identical to those tested.

After the product is listed, follow-up testing begins and is paid for by the applicant. The Follow-Up Service is a method where the testing laboratory visits the manufacturing plant every three months and tests the listed product coming off the assembly line. This periodic testing and evaluation assures that the product has not been changed in any detail and that it still meets the initial standards to which it was tested.

At this point, the applicant is authorized to use the mark of the testing laboratory (e.g. UL or ETL) on the product and in advertising, and may continue to do so as long as the product continues to meet the requirements established by the listing.

Summary

The increasing use of listed electrical equipment in the PV industry is a given. There are major benefits from manufacturing listed equipment. The NEC requires that all equipment be listed, and inspectors are enforcing this requirement. Procedures for obtaining a listing are well established. The cost may be less than anticipated for well designed products.

Access

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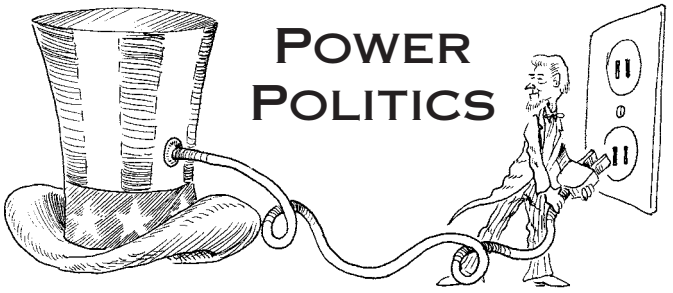


Utility Restructuring in California or *"How the West was Lost"*

Michael Welch

Well, they've done it to us again. California ratepayers and taxpayers will be spending big to bail out utilities' poor decisions to invest in nuclear power. This was part of restructuring legislation passed and signed that took the slow-moving process out of the Public Utility Commission's hands.

California's legislature has done a bang-up job for the utilities whose intent was to bail out the nukes and roll back 15 years of progress for California renewables, while allowing corporate electric rate decreases at the expense of the residential ratepayer.

Deregulation-NOT

Utility deregulation has been written about in several Power Politics and IPP columns in the last two years. I've decided that we can no longer call it deregulation, but must appropriately call it restructuring. Deregulation infers that individual power plant viability, source choices, and consumer prices would all be left to the open market. But that is not what we have. For many years utilities have been given a guaranteed rate of return on their investment in generating facilities, and recently have been allowed to increase that return by operating some facilities at or near full capacity.

Strict deregulation would have put an end to that, leaving generating facilities that can't make it competitively, like nuclear power plants, "stranded," or without customers willing to pay for the plants' high costs. Strict deregulation would have put those plants' losses back in the laps of the company owners, where it should be. After all, it was the companies themselves that foisted these unwanted technologies on communities that didn't want them. They spent millions of dollars and used all the political, social, and economic leverage that they could muster to get these plants sited, just so they could get their guaranteed return on investments. The more they spent, the more they made. If only I could run my business that way.

In the face of possible deregulation, the utilities once again used their amazing sway over our government and regulators to make sure that they did not lose out when competition for their previously monopolized customers began. And it seems to have worked out well for them.

Warning to Energy Activists Across the Nation

California's new restructuring laws do not provide a good example for your state's future. California has the most powerful utilities and some of the most powerful corporations in the world, and they took over the process. Hold California's new law up as a perfect example of why restructuring and, dare I say it, deregulation should be put in the hands of the people, not the utilities and corporations or their dupes in the legislature and public utility commissions.

I strongly urge that your state use the initiative process if it is available to you to enact good, solid law. It is imperative that the rest of the country not follow California's lead if we are to gain control over our energy future.

No Gain for Ratepayers

Under California's newly signed restructuring law, Assembly Bill 1890, the utilities will be paid an estimated $28 billion to retire their stranded assets. Previously, the debt would have been paid off over time as ratepayers consume the plant's power. Under the new law, the payoff period will be greatly accelerated with the state issuing bonds to pay the utilities, and then the bonds will be retired over time through something called a "competitive transition charge" (CTC) paid by residential customers as an add-on to their electric bills. Bottom line? No savings for ratepayers and the utilities recoup their entire investments.

Additionally, there is fear that the big utilities will use the CTC to create unfair competitive advantage. They might raise the CTC to maintain profitability at low electricity rates, while those power companies that are trying to compete in the newly formed market cannot count on CTC money to bolster cash flow. Under this scenario, there is negative benefit to the ratepayer. In the short term, while rates may have been artificially low, the CTC was increasing to keep customer costs up. In the longer term, competition against the big utilities is stymied.

The proponents of AB 1890 and the governor have been touting that the bill will lower rates by 10% beginning in 1998, but that only appears to happen, because the CTC stretches the stranded assets payment over a longer period of time. It becomes smoke and mirrors, kind of like refinancing a home from a 20 year mortgage to a 30 year. Payments are smaller, but more gets paid in the long run. In fact, if utilities adjust their rate caps along with fuel prices, and the fuel prices go up, then some or all of those rate savings will disappear. In the mean time, guess who gets to benefit the most from restructuring. Right, the largest power consumers. Big business will see a savings in the neighborhood of 30% starting in 1999.

Direct Access

This was the whole point of "deregulation." Customers want direct access to the electric sources of their choice. Whether driven by the need for cheaper rates, a commitment to supporting local business, or the desire to use renewable sources of energy, we deserve a choice of suppliers.

This is something that energy activists have been trying to achieve for years, with no success, until big business got tired of paying the high costs of nuclear-produced energy and decided to figure a way to stick the rest of us with those costs.

And they got what they wanted. That is not surprising as the current state administration has created a regulatory climate aimed at making things cheaper and easier for California's biggest business concerns. This is Reaganomics at its worst, and relies deeply on his "Trickle Down Theory." I prefer to call it the "Tinkle On Theory."

Under the new law, direct access is phased in over the next few years. But, like many other things in this bill, it is left to the PUC to implement as they consider practicality and operational and technological issues. Meaning that small customers may not see direct access until the last possible moment.

Renewables

Now for one of the best parts of the bill. For those customers who purchase at least 50% of their energy from renewables, immediate direct access is available. Although it is not entirely clear how this provision will be enacted, the point is to help encourage a proliferation of renewable energy sources by giving their consumers a head start.

Approximately $1.4 billion dollars will be spent over the four year transition period on programs to fund energy efficiency, renewable energy, and "public goods" programs. This money will come from a "systems benefit charge" (SBC) that is collected by the major investor owned utilities (IOU). Each IOU collects a dollar amount specified in the bill for each program that can vary over each of the four years.

Unfortunately, the amounts to be collected reflect adherence to the amounts spent in the last couple of years, so no improvements here. In fact, the utilities cut way back on this spending in 1994 in anticipation of restructuring, and the new systems benefit charges ignore the pre-1994 levels. Funds for low-income programs will also be maintained at 1996 levels.

Also, under the old pre-restructuring policies, SBCs were based on a uniform percentage for all utilities. That is now gone. If the utilities' revenues increase, the funds for more appropriate technologies do not, meaning that the percentage of SBCs to revenues will shrink over time. Many in the industry expect SBCs to disappear after the four year transition period as there is nothing to further encourage their future use.

Administration of Renewables

California's PUC will maintain administration of SBC funds for energy efficiency. However, funds for public interest R&D and renewables are to be transferred to the California Energy Commission (CEC). The CEC is required to report to the legislature by March 31, 1997, with recommendations on fund allocation, including:

• Reward the most cost-effective generation that supports the operation of existing and the development of new renewables, supports biomass, and supports the operation of thermal peaking technologies.

• Implement a process for certifying eligible renewable resource providers.

• Implement programs to use a clearinghouse or a marketing agent to identify the most competitive renewable resource providers while fostering a market for renewable resources.

• Allow customers to receive a rebate that would apply to their purchases from renewable providers.

• Allocate moneys between new/emerging and existing renewable resource technology providers with no less than 40% of the funds allocated to either category.

• Utilize financing and other mechanisms to maximize the effectiveness of available funds.

Disagreement

According to the American Wind Energy Association, "These provisions reflect disagreements within the renewables advocacy community that the committee could not resolve given the time restraint for getting the restructuring bill out. Thus, we must spend the next six months at the CEC and go back to the legislature next year to finalize the renewables provision of the bill."

AB 1890 will also allow customers to make voluntary contributions to support renewables through their utility bill payments. This will also require more specific legislation to be effective.

Loaded Committees

The bill creates three new institutions to oversee our new system. One, the Oversight Board, oversees the other two, appoints their members, and serves as an appeal body for decisions of one, the ISO. The second new creation is the Independent System Operator (ISO). This committee oversees public and private transmission owners, non-utility sellers, public and private buyers and sellers, all users, and public interest groups.

The ISO will primarily provide centralized control over of the state's transmission grid. The third institution, the Power Exchange, is charged with providing and overseeing an auction to meet all the power loads of Exchange participants, open on a non-discriminatory basis to all electricity providers.

It is important to note that there is little chance of these new boards maintaining any kind of representation of non-industry concerns. Their members are to be appointed by the same political methods that shaped this ill-conceived bill in the first place. The governor will appoint three members of the Oversight Board, with the fourth appointed by the Assembly Speaker and the fifth by the Senate Oversight Committee.

Conclusion

I couldn't have said it better than the AWEA, "In our view, this legislation represents a step backwards as compared to the substantial progress toward a more sustainable electric industry that the environmental and renewable energy community had been making with integrated resource planning before the restructuring debates began. What we have in its place in California is fundamentally 'a deal,' not good public policy that systematically addresses the environmental and long-term costs associated with the production of electricity."

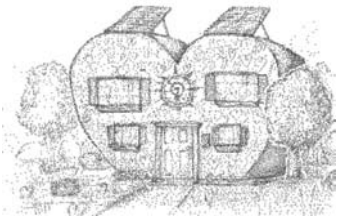
Access

Author: Michael Welch, c/o Redwood Alliance, PO Box 293 Arcata, CA 95518 - 707-822-7884
- Email michael.welch@homepower.org
- The web http://www.igc.apc.org/redwood

American Wind Energy Association, Nancy Rader, 1198 Keith Ave., Berkeley, CA 94708 - phone 510-845-5077 - fax 510-548-4815. For Nancy's complete comments on this legislation, see http://www.me3.org/news/101896ns.html

For the complete text of the California restructuring law, see http://www.energy.ca.gov/energy/restructuring/ab1890_text.txt

Home & Heart



Kathleen Jarschke-Schultze

Since Bob-O and I both have September birthdays we usually ask each other about big gifts. There are always little surprise gifts. We just think that when you spend real money on something it should be what the person really wants. This year we decided to pool our gift budgets and buy ourselves a fruit and wine press.

Happy Valley Ranch

Once we had decided to buy a fruit press Bob-O told me to get my latest issue of Organic Gardening and look in the ads in the back for a picture of a fruit press. Sure thing, there it was, the Happy Valley Ranch fruit press. Back on the Salmon River anyone that owned a fruit press had a HVR press. Since Bob-O was familiar with their quality he called to order the press.

There are several different models to choose from. You can get a Homesteader single-tub fruit grinder/cider mill or an American Harvester double-tub fruit grinder/cider mill. Either of these models come complete, in a kit form or a kit containing all the parts except the wood.

Homesteader

We chose the Homesteader model, complete. It arrived by UPS in several boxes. It did require some assembly, which took about half an hour. The instructions were okay, but not the best. We ended up with some extra washers because there was no mention of them and they were not on the exploded view.

Since the wood parts are bare you have to treat them in some way to protect them. HVR offers a Poxycoat II™, food grade spray on coating that expands and contracts with the wood. We opted for HVR's other suggestion and coated the wood with mineral oil. Mainly because I had two bottles of it left from when we had corn-ear worms. I painted it on and let it absorb for 24 hours.

The Harvest

We have a Golden Delicious apple tree that our neighbor, Stan, says was planted about 15 years ago. After moving here we had to prune that tree for three years to get it back into shape after years of neglect. This type of tree has a crop every year but a bigger crop every other year. We didn't know what variety of apple it was at first so we took a ripe apple to the grocery store and matched it to some there.

I had canned more than enough baked apple butter, apple-pie-in-a-jar and canned apples to last a very long time. If we were to use this tree to it's fullest potential we needed the press.

Apple Eater

The Harvester press has a grinder attachment which chews up the whole apples into pulp giving you more juice when you press the fruit. According to sources cutting the apples up is not as effective and really increases time and labor. The grinding cylinder has eight rows of stainless steel teeth embedded into a 5 1/2" dia. laminated hardwood drum. The grinding box is made entirely of cast iron. A 16" dia., 18 lb. cast iron flywheel attaches to the drum within the grinding box. It is very simple to use.

Start the Press

The apple pulp falls into the pressing tub. The tub is made from hardwood beveled staves and is 12" high, 13 1/2" dia. It is banded with heavy steel hoops. The tub will hold 40 lbs of pulped apples. There is no bottom on the tub. We chose to also purchase the nylon pressing bag with which to line the pressing tub. This was wise. The bag is easy and washable.

The pressing tub rests on a slatted juice rack. This allows the juice to flow freely into the tray below.The tray below is reinforced by a cast iron cross bar. After filling the tub with pulp you then fold the top of the pressing bag over the pulp and insert the press disk. That is a round piece of wood that just fits inside the tub on top of the fruit. The disk has a raised block of wood across the top to meet the foot of the Acme screw. No that's not something the coyote ordered. The Acme screw is a 1 1/2" dia. threaded pressing screw that is 22" long. It is fitted on top with a four prong wheel. This wheel allows you to insert a 2x4 or axe handle to get maximum pressure. A 4" dia. cast iron pressure foot is

attached to the bottom of the screw to evenly distribute the downward force. We put some shortening into the pressure foot when we attached it.

Juiced

The first apples we pressed were the ones that dropped from the tree. We would go out every day and pick up what had dropped and store them in the mudroom. On the weekend we would get up early, to beat the yellow jackets, and press that week's apples. The juice was good and we worked out a system to use and clean the press. Organization is the key to spending a minimum of time pressing. This was essential as the warmer the morning got, the more yellow jackets we had to fight off. We cleaned the press by hosing it down and letting it air dry.

As the fruit on the tree became riper we noticed a definite increase in juice per tub full. We also believe the juice tasted better. After a couple weeks there was too much juice to drink in a week. We got some cheap fermentation locks and started some cider on its way to becoming hard. It is up in the kitchen now, still bubbling. According to *Stocking Up*, a book I recommend, when it stops bubbling it is ready to be bottled for storage.

Conclusion

This is a great press. Without it we (this means me) would never have been able to process all the fruit from our tree. We even pressed Myna and Dave's apples into juice. The cost of our Homesteader, in its assembled state was $429 plus shipping. When Bob-O called they had a 10% off sale going on so we got that applied to our order. It was an investment, but for us it was worth it.

Arborsculpture

I went to a small local barter fair and met Richard Reames. He wrote the book on *How to Grow a Chair*. He had one of his living tree chairs there and also the living peace symbol cherry tree. I reviewed this book in the Feb/Mar Home & Heart after receiving it as a Christmas gift. This is a totally fascinating subject. If you know a gardener that has any interest in trees this would be an excellent gift.

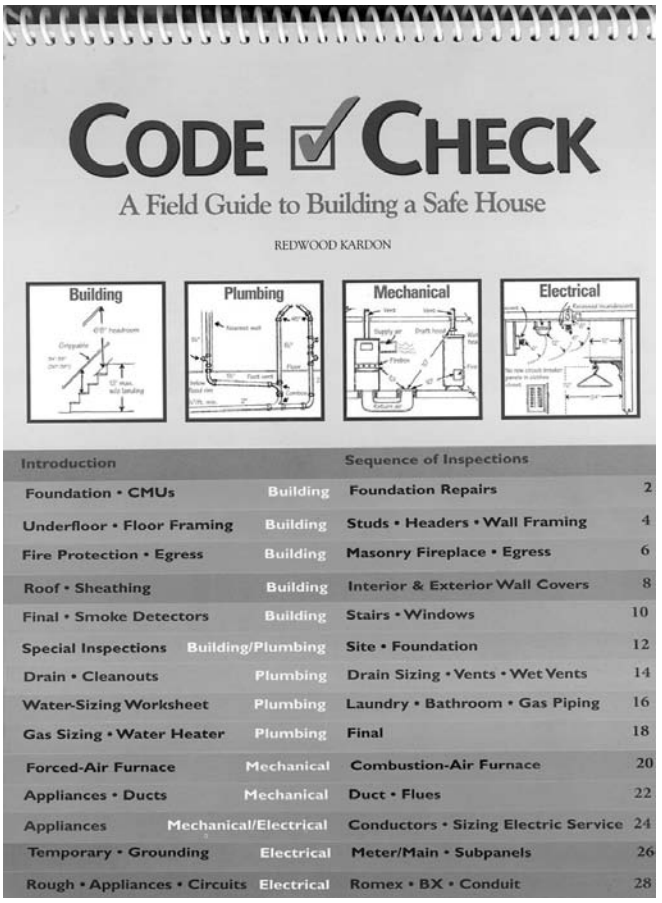
Access

Kathleen Jarschke-Schultze is learning to drive a tractor at her home in northern-most California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830 • Internet Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Happy Valley Ranch, 165 W. 327th, Paola, KS 66071 • 913-849-3103 • FAX 913-849-3104

Richard Reames, Arborsmith Studios, 1607 Cave Camp Rd, Williams, OR 97544 • 541-846-7188 • Internet Email: arborstu@magick.net

Good Books and Videos



Code Check: A Field Guide to Building a Safe House

Written by Redwood Kardon

Reviewed by Bob-O Schultze

By far, the greatest majority of home power systems are installed beyond the grasp of the electrical grid and in rural areas. In most cases, the happy new owners are either building a new home on raw land or remodeling an older existing house or cabin. This generally brings them face to face with the Unified Building Code (UBC) and local building inspectors. Yikes! So much for Nirvana.

Code Check can help. Written by an Oakland, CA building inspector, Code Check steps you thru the seven inspections prescribed in the UBC. Starting with foundations and ending with electrical, the checklists, tables, and drawings are designed to keep you from making the common mistakes that are potentially dangerous, always get the inspectors' attention, and give the builder a correction notice. In fact, most of the items covered come from Kardon's own "top ten" hit list of code violations. Who better than an inspector to know what goes wrong most often?

Code Check has sections on foundations, floor and wall framing, roofing, wall coverings, fire protection, stairs, windows, plumbing, mechanical, electrical, and much more. Mr Kardon doesn't miss much. His section on electrical alone has twenty three sub-headings. Each has pertinent information, tables, and illustrations. His treatment of each part of building a house is clear, to the point, and referenced with the corresponding UBC or NEC chapter and verse.

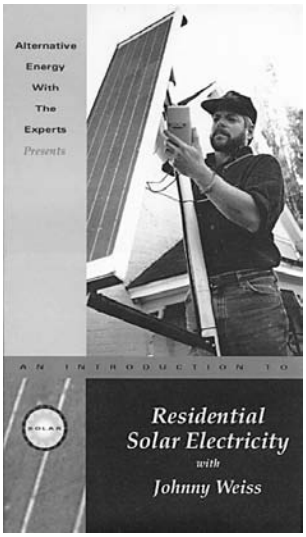
The illustrations are my favorite. In an age of CAD programs and computer renderings, Kardon chose instead to have his booklet illustrated with easy to understand and sometimes humorous pen and ink drawings reminiscent of the "Complete Idiot's" guides to auto repair. This stuff is serious enough. I appreciate the attempt to lighten it up.

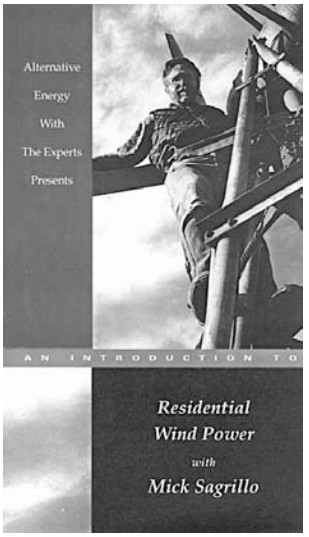
Code Check is bound in a "flip chart" format with each of the section titles visible below the last in the same sequential order a house is built and inspections are made. The paper is heavy stock coated with plastic to make it waterproof. Spilled coffee, greasy hands, and being left out overnight are no problem for this book. A quick wipe will make it readable again. Short of running it thru the table saw, Code Check will handle the rigors of a job site.

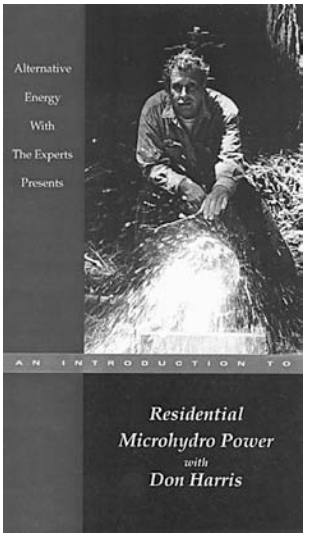
I like this book. It sells for $14.95. For the price, it's a wealth of information; concise and easy to understand. For the owner/builder or small contractor, Code Check puts the code information you need right at your fingertips. It beats the heck out of wading thru the UBC or the NEC for the answers to the most common homebuilding questions.

Access

Code Check is published by Taunton Books
To order call: 800-888-8286 Operator W369
To view Code Check online:
www.codecheck.com







Alternative Energy with the Experts

A series of videos by Scott Andrews

Reviewed by Richard Perez

Here is a series of three videos about the small scale use of renewable energy in home systems. Each video is about 50 minutes long and features an expert in the field. I was impressed with the professional technical quality of these videos, they are far from "homemade." The picture quality is very good, the editing seamless, and the sound quality is excellent. Poor audio has been one of the main features in most RE videos to date.

Each video covers a particular renewable energy source in a very general fashion. The video on photovoltaics is called Residential Solar Electricity and features Johnny Weiss of Solar Energy International as the instructor. The wind video is called Residential Wind Power and features Mick Sagrillo of Lake Michigan Wind and Sun. The hydro video is called Residential Microhydro Power and Don Harris of Harris Hydroelectric is the instructor. Each of these individuals is truly an expert in their field.

These are general information videos suited to the beginner in renewable energy. They cover the characteristics of each particular RE source. The wind and hydro videos contain much useful information about choosing the proper site and evaluating its RE potential. The PV video is far more ambitious and covers controls, instrument, inverters, and batteries in addition to the power source—PV. All the videos follow the "question and answer" format with the narrator (Scott Andrews) asking the essential question of the particular expert. Each video contains quite a bit of footage of actual systems and their operating environments. These videos are not in the "talking head" format which we've come to expect in most amateur RE videos. They are interesting to watch, even for experts, and informative to beginners who are probably seeing these working RE components for the first time.

My only complaint is that these videos contain a mixture of general and very specific information. While these videos do not contain enough information to enable one to design, install, and operate these systems, they do contain bits of data specific to installation and operation. For example, Johnny Weiss shows us how to make an electrical connection on heavy cable, but there is no data on sizing the cable. Don Harris shows us how to field strip the alternator used in a hydro and this doesn't suit the "general" nature of the rest of the info in the video. I suspect that Scott Andrews included the specific info because it is very visual and really suited to video display.

The "Alternative Energy with the Experts" is the best series of introductory videos we at Home Power have ever seen. And we get to view more than a few. The information is concise, the presentation professional, and they are fun to watch. Watching Don Harris measure flow in his creek and watching Mick Sagrillo put up a Bergey 850 wind generator is entertaining and contains much useful info for the RE novice.

Access

These videos are available from Scott Andrews, PO Box 3027, Sausalito, CA 94965 • 415-332-5191. Each video costs $44.95 and that includes shipping inside the USA. Scott has a deal of $105 for all three videos (shipped prepaid in the USA). They are easily worth the price.

HAPPENINGS

CANADA
The Cottage Country Living Show will be held in Vancouver, BC January 10–12, 1997. Some of the topics that will be covered are fix-it tips for around the cottage, energy alternatives, proper care & operation of power tools & small engines, how to buy Crown land, country furnishings on a budget, clean water/safe water. Exhibitors will include builders, designers & architects, recreational property/real estate, alternative energy, water treatment/sewage solutions, building suppliers, portable sawmills, country furnishings, prefab cabins & kits, and small boats etc. For more information write 1030 Mainland St, Vancouver, British Columbia, V6B 2T4, Canada or call 601-683-4766, fax 604-688-0270.

The "Alberta Sustainable House" is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

INDIA
International Conference and Exhibition on Village Electrification Through Renewable Energy, March 3–5, 1997, New Delhi, India. The Conference and Exhibition will cover photovoltaic systems, wind systems, remote area power supplies, mini/micro hydro, solar thermal, health, biomass, biogas, rural communications, project management, remote monitoring, and financing renewable energy projects. The Conference will provide an excellent opportunity to meet with the Indian Government, World Bank, and GEF officials, researchers, project developers and financiers and the leading players in the field of renewable energy. For more information contact: Dr Dilawar Singh, Co-chairman, c/CASE, Level 3, 81 St Georges Terrace, Perth, Western Australia 6000, Australia, phone (+619) 321 7600, Fax (+691) 321 7497. E-mail: case@wantree.com.au

The 3rd International Conference on Solar Cookers Use and Technology, January 6–10, 1997, Tamil Nadu, India. The objectives of the Conference are to bring together experts in solar cooking technology, explore collaboration with other organizations to adopt solar cooking, share educational materials and training programs, exchange views and experiences and develop strategies for promoting solar cooking at the household level, nationally and regionally. For more information: 3rd Int'l Conference on Solar cookers, C/o Chancellor Dr. Rajammal Devadas or Dr. Sathyavathi Muthu, Head of Dept. of Family Resources Mgmt., Avinashilingam Institute for Home Science and Higher Education for Women (Deemed University), Coimbatore - 641 043, Tamil Nadu, India . Tel. +91-422-440 140, Fax +91-422-438 786.

PAKISTAN
APSENA Renewable Energy Conference, December 15-20, 1996, Islamabad, Pakistan. Association of Pakistani Scientists and Engineers of North America (APSENA) had its 13th Annual Conference at Oklahoma City, OK during July 26-28, 1996. Members participating in this conference felt that since Pakistan is experiencing an acute shortage of energy due to many reasons, it would be worthwhile to introduce Renewable Energy alternatives to Pakistani citizens, entrepreneurs, and investors to meet the growing demands of energy in that part of the world. APSENA holds biennial conferences in the capital city of Islamabad, Pakistan, the membership feels that it should included American Manufacturers willing to participate in such a conference to display their technologies or products, as there is a potential market for U.S. exporters to supplement energy shortages. CONTACT: Bashir A. Syed, Senior Engineer/Physicist, Member APSENA, Lockheed Martin SIS, at NASA/JSC, Houston, TX Phone: Home: 713-286-3726, Work: 713-244-1738, E-Mail: <BashiraS@aol.com

UNITED KINGDOM
Weekend Workshops! Have you wanted to build a wind generator, solar PV, water heating system or any alternative technology project? Don't know how or where to start or have no workshop available. Working with other people of varying ability in a well equipped workshop can solve the problems! A series of practical workshops are being held by Robert Keyes GW4IED, of Keystone Systems working from plans or to your design. Held in Newport close to the M4 J25, Saturday 12–6, Sunday 9–4 with hotel & B/B close by, hard standing suitable for caravans available on site. Running throughout 1997. Tel/fax 01633 280958 during office hours for more info.

NATIONAL
Online Energy Info Resources—If you are looking for information on energy efficiency or renewable energy technologies, the US Department of Energy (DOE) has two sources of online access. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. The service is accessible via the Internet's World Wide Web at http://erecbbs.nciinc.com or by modem at (800) 273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is also accessible on the World Wide Web at http://www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an "Ask an Energy Expert" online form that allows users to e-mail their questions directly to specialists at EREC. For more information please call (800) 363-3732.

American Hydrogen Association, national headquarters, 216 South Clark Dr, Ste 103, Tempe, AZ 85281, 602-921-0433, fax 602-967-6601, e-mail: aha@getnet.com "Prosperity Without Pollution" web site: http://www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering free information on Clean Energy for a Competitive America! Learn how to use energy more efficiently. The Department of Energy offers FREE information on topics such as windows, lighting, insulation and tips for energy savers. You can save energy in every room in your house and get advise on major appliances and heating and cooling. Also available—Prepare for Winter! Cut your energy costs this winter by increasing the insulation levels in your home. The DOE's FREE publication, Loose-Fill Insulations (FS140) offers information on cellulose, fiberglass, and rock wool insulations. It provides you with installation, cost, and comparative performance data. Contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; The information can also be downloaded via the DOE's BBS at 800-273-2955 or via internet: http://www.eren.doe.gov

Visit AWEA's (American Wind Energy Association) home page on the World Wide Web. (http://www.igc.apc.org/awea) Visitors to AWEA's home page can obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

Tesla Engine Builders Association (TEBA) provides information about a practical and efficient steam turbine available to the home power producer. The "Tesla Turbine" is the only high power turbine that can be constructed using only simple machining techniques and can operate satisfactorily using only 100 lbs of steam pressure. For more information send an SASE to: TEBA, 5464 N POrt Washington Rd Ste 293, Milwaukee WI 53217-4925; or visit our WWW site: http://www.execpc.com/~teba or send e-mail to: teba@execpc.com

NORTHEAST UNITED STATES
Ninth Annual NESEA American Tour de Sol, US Road Rally Championship for Electric Vehicles, May 17–24, 1997, Waterbury, CT to Portland, ME. For more information on entering or watching the show contact: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

ARIZONA
Solar energy for environmental education! Come join Solar Energy International (SEI) in beautiful Flagstaff, Arizona. SEI announces a photovoltaic design and installation workshop to be held April 28th through May 3rd at Camp Colton Environmental Education Center, located in the pines and aspens at 8800 feet just ten miles from downtown Flagstaff. Thousands of school children spend one full week of their school year at the camp learning about our environment. During the workshop participants will install a PV system to power up the camp lodge. Lodging is available on the site and included in the tuition. Four days of lecture and lab with two days of hands-on instruction. Tuition is $500.00. For more info:Solar Energy International, PO Box 715, Carbondale, CO 81623, tel. 970-963-8855, Fax 970-963-8866, E-Mail: sei@solarenergy.org

The State of Arizona is now offering a 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 job site. For info contact ARI SEIA; 602-258-3422.

Power the Parks! Solar Energy International announces a special workshop for Park Service personnel. This workshop will be held in beautiful Red Rock State Park in Sedona, Arizona, March 17–22, 1997. Camping on site is available. Workshop topics will be based on applications for park energy needs. Sign lighting, water pumping, restrooms, residences, gate entry systems and more will ne covered. Hands-on, lecture and labs are scheduled This workshop is open to the general public also. Tution is $500.00. For more information call or write: Solar Energy International, PO Box 715, Carbondale, CO 81623, tel. 970-963-8855, Fax 970-963-8866, E-Mail: sei@solarenergy.org

ARKANSAS

Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA

1996 North American EV & Infrastructure Conference will be held December 11–13, 1996 in San Diego, CA. The Conference will provide up-to-date commercial and technical information to audiences of all levels. Marketing, government and business issues will be addressed, as well as technical advances made in battery, vehicle and infrastructure development. For more information contact EVAA, 601 California St Ste 502, San Francisco, CA 94108, 415-249-2690, fax 415-249-2699, e-mail: ev@evaa.org

COLORADO

Solar Energy International (SEI) is offering "hands-on" workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program (REEP) features one and two week sessions, PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Cob & Natural Building, Straw-Bale Construction and Adobe/Rammed Earth. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $450.00 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden, CO. The facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

CONNECTICUT

Building Energy '97: Insuring a Sustainable Future; Two Conferences, Workshops and a Trade Show. NESEA's Quality Building Conference and NESEA's RENEW '97 will bring together experts and decision makers from the advanced building and renewable energy industries to describe how quality construction practice, emerging technologies and global market opportunities will shape communities of the future.

Building Energy '97 will provide a launching point for sustainable development in the next millennium, emphasizing green buildings and renewable energy as the foundation. Architects and builders, code officials, land-use planners and landscape architects will discuss how communities can work together to make sustainable development standard practice. For the first time insurance and financial experts will participate in the analysis of renewable energy and sustainable building not only as strategies for loss mitigation, but as the key investment opportunity for "insuring the future."

Renew '97 will focus on the latest developments in renewable technologies in the context of real market applications, highlighting how they can find a niche in an evolving utility environment as well as a booming global marketplace. For more information contact: NESEA, 50 Miles St, Greenfield, MA 01301-93212, 413-774-6051, fax 413-774-6053.

FLORIDA

The First South Florida Sustainable Building Conference and Exhibition, April 10–12, 1997: For building professionals, regulators, researchers and users. Workshops, seminars and exhibits covering sustainability issues in the planning, design, construction, operation and demolition/or recycling of commercial and residential buildings. For more information call (305) 375-1150, fax (305) 375-1157.

MASSACHUSETTS

NESEA is converting its headquarters into a showcase of environmentally responsive building appropriate to the 21st century. NESEA members are converting a historic railroad hub into a working demonstration of a healthy, daylit, office building flanked by a park which celebrates transportation history while demonstrating principles of urban ecology. Opportunities for involvement include • Saturdays at NESEA: A volunteer program through which construction novices learn green building tricks of the trades working with professionals. • Major transformations of the building and park will be undertaken as "barn-raisings." For more info contact. NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

MISSOURI

The Missouri Renewable Energy Association is a non-profit educational organization, promoting energy sensible technologies as a solution to global environmental pollution. Improved energy efficiency. water conservation, recycling, and composting are just a few of the topics on our agenda. We encourage local government, businesses, schools, and individuals to become involved by joining the MO.REA today. For information contact Ray Wathswski, PO Box 104582, Jefferson City, MO 65110, 573-634-5051

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

OHIO

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: Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44, 614-899-6263, Fax 614-899-1717. Internet: DUSSAULT@delphi.com

Solar and wind classes taught at rural solar and wind powered home with utility back-up. Maximum of 12 students. Must advance register. $45.00 fee per person, $50 per couple and lunch is provided. Please advise of dietary restrictions. Class #1 will be full of technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Dates: Every 2nd Saturday of each month. All classes held from 10:00 am-2:00 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

OREGON

The Lane County College Energy Management Program is offering a Passive Solar Design course Winter Term 1997. course content: the physics of solar design, heat load calculations, solar gain, passive solar applications including direct, indirect, and isolated gain, plus shading and cooling design. The course will include a full day tour of local passive solar homes, both new and retrofit . The course will culminate in a design project of the student's choice using the Passive Solar Industries Council software "Passive Solar Design Strategies: Guidelines for Home Builders." Instructors for this course are Tom Scott and David Parker, co-owners of the Energy Service Company and Roger Ebbage, CEM, Coordinator of the Energy Management Program at Lane Community College in Eugene, Oregon. For further information please contact Roger Ebbage at Lane Community College, 541-747-4501 ext. 2451. Out of area call 800-769-9687. E-mail ebbager@lancc.edu or visit our web site at http://lanecc.edu:1080/webpages/lcc/science/home.htm

APROVECHO RESEARCH CENTER offers a ten week Internship Program in appropriate technology, sustainable forestry, organic gardening and indigenous skills. Applications are being accepted now for Spring term which begins March 1, 1997. Tution is $1500 and includes classes, a room in our new solar straw-bale dormitory and delicious all organic meals. Classes typically run from 8:30 am to 5:00 pm Monday through Friday, with plenty of hands-on experience combined with lectures, field trips and fun!

The appropriate technology course is divided into three parts: solar designing, bio-mass conversion and conducting research in these areas. Progressive reforestation techniques are studied and practiced, as well as the sustainable harvesting of forest products such as mushrooms, vine-maple for fencing and basketry, and herbs for medicinal and aesthetic purposes. More productive and integrative methods of farming, including permaculture, are also studied while working in our beautiful organic garden.

Aprovecho Research Center is a non-profit educational institute located on forty acres nestled deep in the forest of Oregon. Internship programs March 1, June 1 and September 1 of every year. We also offer a six week winter internship in Baja Mexico which focuses on studying and researching appropriate technology applications, learning Spanish, teaching in a grade school and working in fruit orchards and gardens. Call 541-942-8198 or write to: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424.

VERMONT

Free PV Workshops for beginners to experts given by David Palumbo of Independent Power & Light, First Saturday of every month at the Palumbo/IP&L PV and microhydro powered off-grid neighborhood. Participant interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, charge controllers, inverters, lighting (ac & DC), balance of system components, system monitoring and maintenance, water (finding it, developing it,

transporting it, pumping it, and getting power from it), snow (living with it, playing with it, and removing it), ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet people who are either living with renewable power or considering it. David Palumbo has taught workshops in the past with the fine people of Solar Energy International and with the real good folks of the Solar Living Institute.

Call, fax, or write for your reserved spot, information, and directions. 9 am to 3 pm the first Saturday of every month. David Palumbo/ Independent Power & Light, RR1 Box 3054, Hyde Park, VT 05655, call or fax 802-888-7194. This is a freebie so bring your own lunch and coffee.

WASHINGTON, DC

SOLAR 97 American Solar Energy Society Conference. In conjunction with Soltech 97. For info: ASES 2400 Central Ave Suite G1, Boulder, CO 80301 • 303-443-3130 • ases@ases.org • http://www.ases.org/solar.

Solar Energy Forum, April 25–30, 1997, Washington DC. The combined annual solar events of: American Institute of Architects, American Society of Mechanical Engineers, American Solar Energy Society, Interstate Renewable Energy Council, Solar Energy Industries Assoc., Utility Photovoltaic Group, and the US Department of Energy. For more information contact: Michelle Birkenstock, SEIA, 202-383-2620, fax 202-383-2670 or Erin O'Donnell, UPVG, 202-857-0898, fax 202-223-5537.

WISCONSIN

The Midwest Renewable Energy Association Fall Workshop Schedule. Learn more about energy conservation and renewable energy through experiments and demonstrations. Energy education activities, classroom projects, and curriculum ideas for grades K-12 and youth groups will be explored. Tour alternative energy homes in the area. Co-sponsored by the Central WI Environmental Station, Midwest Renewable Energy Association and WI Center for Environmental Education. 1 UWSP credit available. MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; phone 715-824-5166, fax 715-824-5399

the Wizard speaks…

Anti-Gravity

Recently, reports have surfaced in the alternative media concerning anti-gravity. News out of Finland seems to indicate that gravity can be manipulated by electromagnetic forces.

The experiments used disks and toroids made of a ceramic superconducting material. These were made to float and spin above a magnetic field. This is possible because superconductors exclude magnetic forces when in their superconducting state.

In early experiments, gravity was reduced by 0.04% above a floating disk and up to 0.3% above a rotating disk. This latter figure was increased to 2% in later experiments. Similar results were achieved with toroids. The speed of rotation was an important factor. At some speeds gravity was increased.

Changes in atmospheric pressure were also noted. These occurred on all floors above the device. Doubling of the effect happened when two devices were stacked one above the other.

It appears that electromagnetic forces can have an effect on gravity. One explanation is that the electromagnetic forces are disrupting the equilibrium of the zero point field This disruption would then give rise to a change in the gravitational interaction.

These experiments in Finland have opened a whole new era of scientific investigation. This may lead to advances in free energy and transportation. Stay tuned.

Pow R. Maker
Sunnyville, Earth

Home Power Letters
P.O. Box 520
Ashland, OR 97520

IRENEW—A Big Success

All good intentions are constantly being directed in the wrong direction around here. I have tried to get this letter off to you.....many times.

Our energy fair was the biggest success ever. I still have a hard time believing the participation by Trace (donation of an inverter for auction), an inverter donated by Exeltech for IRENEW's "Power Trailer" with approximately 1200–1500 watts, Ed Passerini from the U of Alabama with his homemade solar cars featured in the last issue of Solar Today, four Electrathon cars from Michigan racing on the Hawkeye Downs race track, to Congressman Jim Leach from Washington DC, a soybean powered boat that has traveled around the world, the Marquette University's PV-powered race boats that have won international competition in Japan. This was FUN!

Before the Expo, IRENEW manned a booth at the Iowa State Fair in Des Moines for ten days. In that ten days over 750,000 people went through the tent next to the windmill on the fairgrounds. IRENEW also had a tent at the International Farm Progress Show in the AMANA Colonies here in Iowa. Over 200,000 people attend this every year. VP Gore attended the show and Wednesday Dole attended the same show WE have arrived!

This coming spring (March 31-April 5) SEI from Colorado is holding a workshop for us in Cedar Rapids on PV at the Indian Creek Nature Center where we will be installing 24 of the PV panels from Brookhaven National Labs (approx. 1000 watts). This will be on their calendar this fall.

One of these days I am still planning a series for you on active solar heating, but the six hours of college classes I took this summer took all my spare time. Thanks for all you have done for us. Tom Snyder, President for the next, and my final year, IRENEW, Dyersville Iowa

We're very pleased to hear that IRENEW is doing so well. Grassroots organizations such as IRENEW are reaching many new people. We, at HP, know how much work it is to accomplish even the smallest energy fair. We salute you! Richard Perez

Code Compliance

Last year I was involved in a wind-powered electric vehicle charging station project at the Port Townsend High School. The project ended when the State Electrical inspector said No to using anything that was not UL listed.

Our plan was to use a High Voltage Whisper 1000 (unlisted) generator to charge a 32 kW, 144 VDC battery bank (unlisted). A high voltage charge control was to be built by the students as there are none available on the market (unlisted). The power from the battery was to be dispersed through a Curtis 1231C (unlisted) controller and high power inductor (unlisted) to an EV. Correct polarity sensing and disconnect circuit were also included and to be built by the students (unlisted).

Yes, we were dealing with a lot of power and we were trying something new, which of course would be unlisted. The plan we devised included batteries, controller and metering that were duplicates' to those of our winning Ford Probe race car. These could be removed for the trip to Phoenix each spring.

The NEC has made a lot of new regulations for 1996 concerning EV charging (enclosed). However, when I tried to find out who made equipment that would meet these regulations I was unable to find anyone. I am referring mainly to the type of interface between an EV and its charger. The Seattle Square D distributor was unable to identify the charge receptacle shown in fig. 625-2 nor was he able to provide any other appropriate plugs.

I guess what I am really trying to say is that regulations are surely needed, but that the products need to be available BEFORE the regulations.

John Wiles does a great job in the Code Corner, But only talks about photovoltaics. Would he be interested in also addressing wind & EV code compliance?

Also, even though UL listing is very expensive I feel that it is necessary given the regulatory facts of life. This means that

all manufacturers need to consider this and that you folks at Home Power need to do as much as possible to point out to your subscribers the necessity of checking with local authorities about what exactly is required before investing a lot of time and money in alternative energy projects.

Needless to say, we were pretty bummed out when told that we could not proceed. A lot of time and money had been expended due to our ignorance.

I am enclosing a copy of our projected charge station. We were going to build each section separately to verify operation or redesign before assembling the complete unit. Thanks for listening, Karl Schreiber, Port Townsend, Washington

Sorry to hear that code compliance stopped your wind/EV project. John's columns have dealt with code compliance in the last two issues. I think we need some type of code exemption for "experimental" equipment. If this doesn't happen, then how are we supposed to develop new ideas? Richard Perez

One Method To Avoid Rip-Off's
When shopping interstate for new or used "stuff" I contact the party and advise them that I would like to buy their item/s. I explain to them that I will send them a cashiers check made out to him/her thru a bank or attorney in the state that they reside. If they are legitimate they usually go along with my terms. If fraudulent they usually deny.

I make arrangements thru a reputable bank/attorney on a release password, usually a "social security number" to be asked by bank/attorney prior to remitting check. This is to keep payee (if fraudulent) from calling, impersonating me prior to shipping item. He/she will be asked for password before the release of check, the odds of coming up with the same number I designate are astronomical.

Shop around for the service. It has cost me $50-100. Well worth not being ripped off. P.S. That might be another line your outfit could get into, you could be the intermediate. We all trust you. Sylvan Salem, Pagosa Springs, CO

While I am flattered that you trust Home Power, there is no way we can act as a secure broker for microad sales. We just don't have the time. The recent ripoff artist who used our microads to defraud our readers is the first instance in over nine years of publishing Home Power. By and large, the people selling used gear through the microads are honest folks. We have started "vetting" all advertisers in Home Power for honesty. If we find that the business deal seems potentially dishonest, we investigate it before we publish the ad. This applies to display as well as microad advertisers. Your suggestions regarding buyer protection are a great idea and I hope our readers will follow them on large purchases. Richard Perez

Where's the Beef?
I've only seen one issue so far as this area of the country is not a hotbed of creative thinking and magazines such as yours are hard to come by (hence the subscription). I'm awed at the amount of information contained in just this one issue, June/July 1996. Your magazine and website have a lot of meat. The only other solar magazine I could find was all whipped cream and sprinkles—pretty to look at, but it left me unsatisfied. Vanessa Quinones, Kingston Springs, TN

Thanks for the flowers, Vanessa. We try our best to keep the info in Home Power useful and detailed. The credit really goes to our readers who write-up their experiences for publication in these pages. We have become very demanding of our authors—we want all the details, the schematic, cost tables, load tables, in addition to a well written story and some good photos. And as HP readers are doers, they deliver! Richard Perez

What A Concept
Hey! What a concept—solar power. I might not have ever heard of it before. And here I thought "energy conservation" was going to "light our future." We should all be solar now, 23 years after the original oil embargo, but this country is the crowning achievement of the capitalist system, and although it is talked quite to death as a concept, and used to justify everything from political repression to higher prices and fewer choices, an intelligent person doesn't really expect to find practical, in the field or on the ground working democracy in a political, economic or social system as ours, which leads me to wonder what advances in renewable energy are being made in Cuba. I'm sure they would welcome a donation of some solar panels or wind generators. Lucious Walker almost killed himself to push the medical computers through. Nothing ventured, nothing gained.

Down at my local library they had only two prehistoric books on solar power. I asked the librarian if she would like a subscription and she said, "Yes." Enclosed, please find a check for a one year subscription for me and a gift subscription for the library. Sincerely, Brian Higgins

Thanks Brian, and thanks on behalf of your local library. Our thing is to get the information out there, and we're more than happy to take on half the cost for libraries (see the Adopt a Library ad in this issue). We're glad you remembered to check with the librarian before ordering the sub. Michael Welch

Keep 'Em Coming
No complaints, just keep 'em coming. I've received your magazine since #2 and all of my back issues are on file in the Lowville Free Library. A friend, Russ Hoffman filled in the ones I'd lost so they have a complete reference set except #1. Maybe someone would have one to sell, or if we could even get a photocopied leaflet from your office of your first issue. Let me know. Edwin Falk, pfalk@northnet.org

Nice of you to make your back issues available to the public. You can get a photocopy of issue #1 by contacting the Iowa Renewable Energy Association at 319-875-8772, or 611 Second St. SE, Dyersville, IA 52040. We have given them permission to photocopy Issue #1 and sell it as a fundraiser for their fine organization. Michael Welch

Phantom Loads Measurement Made Better
I am a great fan of your magazine and each issue is a "must read." The October / November 1996 issue has a Michael Lamb article titled, "Phantom Loads Update." What a great idea…actually measuring phantom loads and calculating the watts for popular home appliances. The tester box is easy to build and, with some extra safety precautions, will work fine.

The reason I'm writing is my belief that the math described in the article will not give an accurate watt reading of the phantom load as the appliance is used. The instruction to multiply I (current flow) by E-line (outlet voltage) will give a good reading for watts while under test.

However, this is not enough to determine the quantity of phantom load for the appliance if it is plugged into the wall outlet without the tester box.

The tester box places a shunt resistor (1000 Ω) in series with the phantom load, figure 1. This is not the same as the phantom load circuit without the shunt resistor as in figure 2.

Figure 1

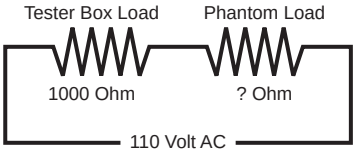


Figure 2

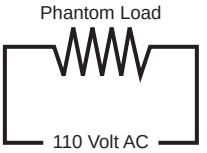
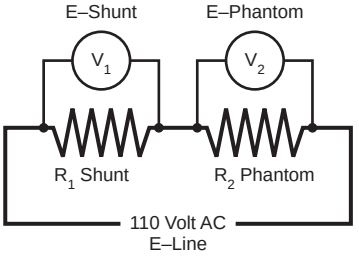


Figure 3



Formulas

$$\frac{\text{E–Shunt}}{\text{E–Phantom}} = \frac{\text{R–Shunt}}{\text{R–Phantom}}$$

$$\frac{(\text{E–Line})^2}{\text{R–Phantom}}$$

One way to find the phantom load in watts is to use the tester box and math to determine the value in Ohms of the phantom load. By using the test box and measuring the shunt resister we know V1 and R1 (figure 3). By subtracting V1 (E-shunt) from E-line we know E-phantom. The voltage drop across each resistor is proportional to the ohm value of the resistor

E-shunt/E-phantom=R-shunt/R-phantom

By using that formula, R-phantom can be calculated. With the phantom resistance calculated, the phantom load in watts can be calculated using the formula

(E-line)squared/R-phantom

This will give the phantom load in watts when the appliance is not connected to the test box. Carl Berger, East Aurora, New York

You're right, Carl. If the resistance of the Phantom Load is low, then the shunt resistor will limit the amount of current flowing in the circuit and make the measured Phantom wattage low. Although it's enlightening to quantify the amount of energy wasted in Phantom loads (as Michael Lamb did in HP#55, page 36), this is really academic. In a tactical sense, our mission is to identify Phantom Loads, and then unplug them regardless of how many watts they consume. Solar electricity is too expensive to even consider wasting a single watt-hour of energy. Richard Perez

Solar Powered Distillation?

I live next to the ocean in Baja, CA, Mexico. I have to truck in all my water needs for household and gardening needs. I am looking for the most economical RE system for converting sea water to fresh water, about 400 gallons a day. Thomas Melville, Chula Vista, California

How about it, readers? Can anyone help Thomas with this project? We might recommend solar stills, but 400 gpd is a lot of water! Michael Welch

Attach a Chain

Enclosed, please find my check to renew my subscription and pick up these six back issues.

I have loaned out some of these issues and they disappeared. Maybe you should warn you subscribers about loaning out issues without having a chain attached.

I enjoy your publication very much and eagerly look forward to each new issue. How about an article letting us know how you weathered the power outage in early summer when the whole western U.S. was without power? Has that situation gotten the attention of any of the fossil fuel zealots?

Keep up the good work and enter my renewal right away—can't afford any lapse. Sincerely, Bob Neumann, Fruita, Colorado

Great suggestion, Bob. I know that when I loan any of Redwood Alliance's issues or other reference materials, I write down the name, address, and phone number of the borrower, both so I know how to get in touch of them and as a reminder that I did loan the material out.

But, power outage? What power outage? I'm being facetious, but the only result I have seen to date is that customers are taking the utilities to task for not having their maintenance and communications trips together. It is unfortunate that nobody is using the outage to push for decentralized renewables. But, when this sort of thing happens it presents a great publicity opportunity for renewables advocates. See the Power Politics column in Issue #51. It outlines how to compose and send out press releases and letters to the editor, as well as how to get them to the media in a timely fashion. It is up to all of us to make a difference for our energy future. Michael Welch

Well, Bob, an article of how Home Power, here on Agate Flat, weathered these massive blackouts would be boring. Nothing happened here that doesn't happen every day. The sun shone and the wind blew. We had continuous electric power just like every other day. Richard Perez

Web Links

We enjoy HP very much. I don't usually read the EV articles because we are building a PV powered home and couldn't charge the car batteries. I would like to see an article about hydrogen cells or fuel cells.

We have a web page on the house we are building (http://www.phys.ufl.edu/~liz/home.html) and it gets quite a few visitors. We often give people your URL and email address when they ask about info on off grid living. I plan to put in a link to your page. Thanks for all the good work! Liz Seiberling and Randy Cullom, Hawthorne, Florida

Hey, Liz and Randy. Sounds great, but I wouldn't write off EVs yet. Get your household up and running then keep it as a goal to eventually add an EV to your renewable energy lifestyle.

Our web URL is www.homepower.com, but you can find information on how to link to us and get us to link to you at www.homepower.com/linkform.htm. We welcome readers, non-profits, and advertisers on our link pages. We also have a special links page for folks that don't quite fit into those categories. Our pages are getting around 1,200 hits per week, so folks must find it valuable. Michael Welch

The Good New Days

In the old days, Issue #36 and that period, the cost and complexity of off grid power overwhelmed me. However, in Issue #54 I found more advertisers and options that appear affordable, straightforward, and doable. The well written articles with systems illustrations leave me with an understanding I can build on to create a system for my needs—thanks. How about a fair in southeast U.S.? Rich Calhoun, Atlanta, Georgia

Great idea on a southeastern US energy fair, Rich! These fairs begin with a dedicated core group in the area. This group works their butts off doing organizing for months (and in some cases years) before actually staging a fair. If you want a fair in your neighborhood, then first organize this core group. We at HP are happy to provide publicity to help the core group get their message to the public. You will find that other energy fair groups, such as the MREA and IRENEW, are very willing to share their experiences. This prevents everyone from making all the same mistakes the first time. Richard Perez

Windy Collateral

Hello Home Power. My most heartfelt thanks to all of you, your hard work and dedication, and your superior magazine! I'm still struggling along here in the bush of beautiful South East Alaska. My fledgling AE business and AE projects are moving along in fits and starts.

The 10 kW Jacobs mill and 120 foot tower, new house and shop, battery shed for a 2000 Ahr 120 VDC system, and other related projects are turning out to be a BIG bite for this 100% service connected, disabled vet to handle.

But, with inspiration from you and others like Mick Sagrillo, the folks at SEI, and Bob-O, I keep pluggin' along. I thank you all from the bottom of my heart!

A note for you IPP people—I got a $10,000 loan on the Jacobs mill and tower from 1st Bank in Wrangell, using the Jake as collateral. Thanks again, Robert Davis, Wrangell, Alaska.

Good work, Robert! Banks have been generally slow to realize the value of renewable energy. To actually get this loan using the equipment as collateral is a stupendous feat and is very encouraging to us all. I've often found it ironic that a bank will lend us $30,000 for a gas guzzling automobile, which will be junk about the time its paid for and pollute our environment, but they are reluctant to lend for an independent RE system which outlasts many cars, frees us from the grip of utility bills, and does not pollute this planet. It make's a fella wonder…. Richard Perez

We Don't Know

1. Is it recommended to use a wind generator in Big Sur on the coastline, or is it permitted in view areas?

2. How do I get plans to install a solar water heater for a swimming pool? Vilmos Zsigmond, Los Angeles, California

Hi Vilmos. The short answer is, "We don't know." But, the long answer should come from a local installing dealer that is familiar with the area you are considering. We can't say enough about taking advantage of the cumulative knowledge and experience of such a company to help you determine your needs and then getting a system up and running. The only other way is to do the extensive research, sizing, and installation yourself. Many folks are up to that task, but many are not. We endeavor to give readers the info necessary to take on these kinds of decisions and jobs themselves. But when it comes down to a specific site, we can't help much. Michael Welch

For your solar pool heater, contact the folks at Solar Depot at 800-822-4041, they may also know about wind zoning. Also contact your local building codes folks for restrictions on towers. If you can't have a wind genny (and Big Sur is a windy place), then consider solar electric (it has enough sun according our readers who live there). Richard Perez

Home Made Charge Controller

A very informative magazine. I like your product reviews and new products ads. I especially like the Homebrew articles as I like to build my own when I can. I built and designed my 40 Amp Pulse Width Modulated controller for battery charging for under $50 and gained 20% more efficiency over my old shunt type regulator. I will send you the plans if HP if interested. Keep up the good work, Ronald Stowe, Snowflake, Arizona

Interested? We're very interested! We would love to see your plans. Just write them up in an article format and send them to us with a readable schematic, photos, and parts list/cost table. We would love to print such a project, and we rely on our readers to supply almost all the articles we publish. Everyone should feel free to send us articles and proposals, we wouldn't make it without them! Michael Welch

Tax Advantages?

I have kept copies 1 through 50. Please keep us up to date on electric cars, better batteries, and solar panel changes in efficiency. Perhaps solar roofing materials for houses (lower efficiency permitted here) but maximum power per dollar spent is of interest.

Once there were tax advantages for going solar. Is there any renewed interest in this in Washington D.C.? Robert Hester, Pearblossom, California

The two criteria that determine solar electricity's future are cost (in dollars per watt) and longevity (at least ten, or better yet twenty, years lifetime). PV modules are now costing about $5.25 per watt and already come with 90% power warranties of ten to twenty years. If the price of PV drops to about $2 per watt, then it becomes our cheapest energy source. In off grid systems, the PV has already replaced the engine/generator as the prime energy source. And this happened in about ten years as PV prices gradually dropped below $7 per watt.

As far as I know there are no federal tax breaks or incentives for solar electricity in residential applications. There are some states who offer breaks for solar, but nothing nationwide. It's an electron year and, as usual, energy has largely been ignored. With the general belt tightening and tax cutting, I think it unlikely that we will see federal subsidy of independent RE systems. It looks like we'll have to do it ourselves without aid from our government. So what else is new? Richard Perez

Grid Battery

I would like to see a listing of suppliers that have an inverter-controller that ties PV cells directly into the grid with no batteries—the grid would be the "batteries." The system should slow down your electric meter or even run it in reverse. Christopher Kelsay, Eugene, Oregon

The following inverter manufacturers make utility intertie models:

Exeltech, 2225 E. Loop 820-N, Fort Worth, TX 76118 • 817-595-4969 • FAX 817-595-1290

Omnion Power Engineering Corporation, 2010 Energy Drive, POB 879, East Troy, WI 53120 • 414-642-7200 • FAX 414-642-7760,

Pacific Inverter, Inc, 509 Granite View Lane, Spring Valley, CA 91977 • 619-479-5938 • FAX 619-479-1549

Trace Engineering Inc., 5916 195th N.E., Arlington, WA 98223 • 206-435-8826 • FAX 312-644-6505

Vanner Weldon, Inc., 4282 Reynolds Drive, Hilliard, OH 43026 • 614-771-2718 • FAX 614-771-4904

Some work with a battery, some without, and some work both ways. I think that having at least a small battery is a good idea. This allows your house to have uninterruptible power during short utility blackouts. Richard Perez

Thank You!

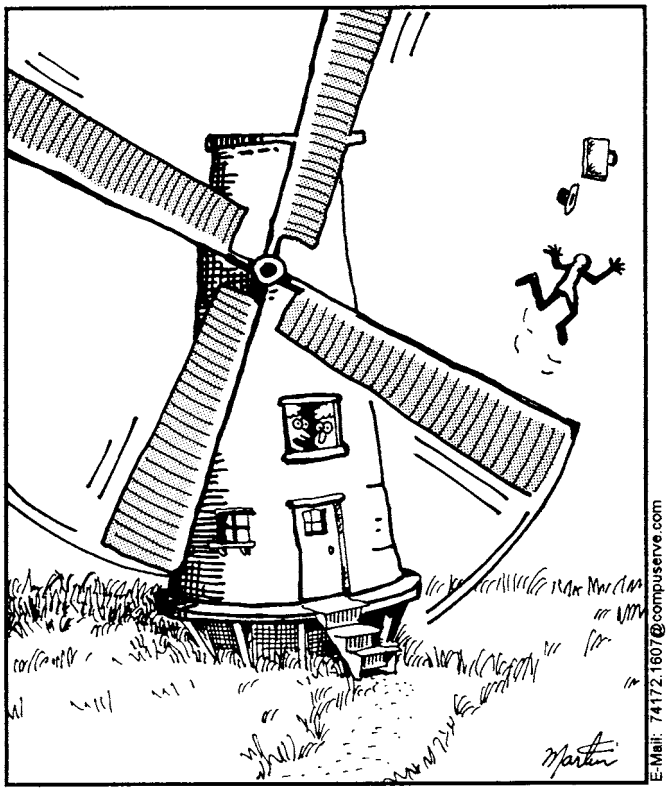
Being independent of runaway energy costs is a goal many share. I plan on the day that I can build my home and incorporate many of the ideas and technology that this magazine teaches me. I read many magazines, but this one has outstanding descriptions, comparisons, and knowledge. I want to thank you and all the people who put this information together. You continue to help educate me and save me much money! See you off the grid soon, Tim Biffle, Corona, California

Thanks for the flowers, Tim. The HP Crew works hard and it's nice to be appreciated. Richard Perez

Gods of Solar Enlightenment

Dear Home Power. I waited and waited…could it be our subscription has run out! Egad! How could this be possible, after getting every single one since the beginning of Solar Time! Please, accept my humble apologies and take this offering of cash to appease the Gods of Solar Enlightenment, so that wisdom and common sense will survive amidst the deluge of junk mailers! Yours eternally off the grid, Michael and Linda Kirschner, Arcata, California

Oh thank you, loyal followers of photons. The gods smile kindly on those that send us clams, and especially those that trim green expanses and put colorful waters on stretched canvasses. We love you too! Michael Welch



"See, I pull this handle, get free electricity, and the salesman is gone with the wind…."

Lightning Strikes Again

Just when you think you'd seen it all... my son put in an extension off my 1.5 mile phone line to a cabin he and his friends used. Then the county road grader came thru (first time in 11 years!) and tore up the line where it was buried under the road. so, they hung it in the trees til they got around to burying it again.

I told them it would not do… that the wire would act as an antenna for waves from any lightning. AND, a couple nights later there was a close hit in the yard up there… fried my phone, their extension, and blew every splice and a lotta wire to kingdom come. It also blew my MOVs.

The Metal Oxide Varistor is supposed to pass high voltages; in this case, over 150 vac. [the ring signal is 90 vac], and in this case, it did, but it couldn't handle *that* much. I heard it pop before I heard the thunder a mile away.

Last spring we got a hit 100 feet from the house which exploded a 2 foot diameter tree and fried my modem... and my MOVs, which at that time were little cylindrical dealies 3/16" in dia. In light of all this, I would suggest the bigger ones, 3/4" dia discs that can take 100 amp or 80 joules. I have a hard time seeing how a typical 24 AWG phone wire would need anything this big, but they are only about $.75 each, and you only need one between each of the two Telco wires and a really good ground at your house. Day Brown, via the Home Power BBS

Thanks for the tip, Day. Even though the phone wires are small gauge, they can transmit lightning. Lightning induces a

high voltage transient onto the phone line. There is no real current flowing through the phone line until one or more of the phone appliances (or a MOV) fails due to overvoltage. Once there is a short circuit somewhere in the phone system, then large amounts of current flows as things fry and die. The idea behind the MOV is that it is a sacrificial component which protects phone appliances from overvoltage by its death (from overcurrent). Unfortunately as the MOV conducts in an attempt to keep the voltage on the phone lines down, huge amounts of current flow through the phone line. This is what fried the phone wires and their connections. Try MOVs not only at your home, but also at the beginning of your long phone line. Lightning is wicked stuff and in spite of all we do to protect ourselves, it still can bite. Richard Perez

Flowers and a Question
Hello Home Power! My wife and I are in the start-up phase of a new business. We will be opening an eco-tourism business in Costa Rica in December of '97. Our emphasis is on providing mountain bike tours of the Peninsula de Osa. Our name is La Llanta Picante (that's "The Spicy Tire" in English). We are located on a 100 acre property in a very remote and fragile estuary/rainforest environment, one that we are very committed to preserving.

In fact, we are in the process of reforesting the pastures of what was once an old farm. Unlike many of your readers we are making the jump to RE and alternative household systems in one big jump, but not without the help of professionals. Since we met, my wife and I have dreamed of living a more self reliant lifestyle and your magazine is giving us the practical knowledge and confidence to make the transition. We both look forward to seeing it in the mail every month and have made extensive use of your CD-ROM in our frequent research. With every article we feel ourselves changing and growing in commitment to living within our means. We hope to leave our children with a better example for the future than this endless consumption of resources that marks the average American lifestyle. Thank you for being there for us.

Question: I have two rechargeable bicycle lighting systems. Each uses a 6 volt Ni-Cd battery. Theses are charged with an AC 120 volt to 7 Volt at 700 mA plug-in charger. I have a MSX-10 Lite solar module and would like to hook my batteries in series and use this panel to charge them. Will this work?

We are also looking for any additional information on the specifics of operating a composting toilet in the tropics. Thank you again, Tim Ingram, Rock City, Illinois, spicytire@aol.com

Hello Tim. Your Solarex MSX-10 Lite PV module will charge either a single 6 Volt battery or two batteries in series (making 12 VDC). PVs are constant current devices (within their voltage range). The MSX-10 Lite has a rated current of around 600 mA and will deliver this current into either a 6 or 12 VDC battery. So charge away, one battery or two, both will recharge well. Be sure to limit the charging time in order not to overcharge the sealed Ni-Cd batteries.

I can see no special problems for a composting toilet in the tropics. In fact, the unit will probably like the high ambient temperatures. Call the experts at Advanced Composting Systems at 406-862-3854, or see their ad in this issue. We are in the process of installing one of their units and I'm impressed with its industrial quality. Steve and Elizabeth at Backwoods Solar also use an Advanced Composting unit and they report favorably. These folks build composting toilets large enough to handle the crowds at some of America's National Parks, so they can easily provide the toilets you need for your business. Richard Perez

More Flowers
I'm really stunned by the high quality of HP. It's the printing, the general layout, the language used, the paper, and above all, the endless cornucopia of useful information on renewable energy.

It's one of the best magazines I've seen in years. No question about it. Do keep up the good work. José Almeida de Souza Jr., Campinas, San Paulo, Brazil

Thanks, José! We try and I'm glad you appreciate our efforts. We keep the info technical, the articles unbroken (no continued on page whatever), our printer is aces (Thanks St. Croix) and the paper is the best we can find (high recycled content with no chlorine used in making it). Most folks don't notice and we are very pleased that you did! Richard Perez

Still More Flowers
Please keep up the good work! Please write about the roof-top shingles I have heard are currently being produced. Here is my check for a renewal Paul Teckley, Huntington Beach, California

Thanks, Paul. The PV shingles you mention are being produced in limited quantity for test and demonstration purposes. At this writing they are still working on gearing up for production and marketing, and designing the final scheme for wiring the shingles together. There's a lot of promise in this product, but they will be aimed at the high end architectural design market at first. Hopefully, remote users will be able to take advantage of this new technology in the near future. Michael Welch

Even More Flowers
I love your entire magazine. Everyone who is planning to build or expand should mandatorily have to read Home Power!

I don't like to read about engine/generators unless they are using alcohol or hydrogen fuel.

Which PVs are the best for the $ ("Consumer Reports" style tests)? Shawn Waggner, Bloomington, Indiana

Thanks for the flowers, everyone. Shawn, all I can say is that engine/generators are a necessary evil at this time, but we look forward to the day when renewables are cheap enough to totally replace infernal combustion engines. I agree, we should limit the burning of anything that makes carbon dioxide. We should be doing another comparison article on PV modules in the not-to-distant future. There are so many kinds of PVs for sale that it is impossible to pick a "winner." They don't all perform the same, the costs are different, and the physical sizes and characteristics are different. Different environments and different usage habits make different PV modules applicable. Just like boots, one type and size doesn't fit everyone. Richard Perez

Politics, Yea or Nay
I am an AE participant primarily due to your magazine. While I can certainly appreciate the need for political viewpoints, they seldom swing the pendulum unless they are expressed in front of the proper audience. Preaching to the choir doesn't seem appropriate use of limited space. More useful information about the field of AE and possibly more about new products would help those of us actually interested in using your magazine. Thanks, K.M. Jones, Kissimmer. Rhode Island

A nice thing about opinions is everyone's got one—even us! While we often wrestle with using our space for such, it is evident that the future of renewable energy is closely tied to how governments accept, fund, and implement energy policy. Wouldn't it be great if it wasn't that way, but it is. And you would be surprised about the wide range of readers that Home Power has. We have liberals, conservatives, back-to-the-earthers, EarthFirst!ers, JobsFirst!ers, survivalists…well, you name it, and not all are in "the choir." We endeavor to keep our political side as information rich as possible while keeping potentially "offensive" opinion to a minimum. An impossible task, but most of what you get has a direct impact on the future of renewable energy. It also has ways that you can personally effect it. Michael Welch

HP Issue #100
Hello, it's been a long time since I wrote HP a letter. I had written quite a few in the last few years. I remember writing and suggesting you move your sub form to the middle of the magazine so I could undo the staple and save my highly collectable HPs. I have them all except #1. It is still a treat and my wife says I act like a kid when I get it. It always makes me smile.

Sorry to hear the losers have found HP in the advertisements. The world is truly becoming more amoral.

I have a Vitalizer I bought years ago from a big AE company and never used it. I have saved it through 3 moves now and will GIVE it away to anyone that wants it. Let me know if you know someone.

Still waiting to build my dream solar home. Now that I am living in Bend it is more feasible. I PROMISE you will like it and it will be the most futuristic place you have ever explored. I already have a name, Earth Outpost #1.

Well, talk and dreams are cheap. God bless and good luck, will be looking forward to HP#100. Dan Cosgro, Bend, Oregon

Big Bucks Rebuild
I enjoy your magazine very much. Having only gotten the last six issues, I am sure I have missed a lot. Could you make up a list of back issues and list the topics in each one, kind of like *Mother Earth News* does with their back issues?

My biggest complaint is the prices of some of these products. I have talked to other people also, and that seems to be their feeling as well. Especially us po' folks on limited income. I had a chance to buy a damaged 10 kW Bergey last year, but after I called Bergey and they said forty two hundred dollars for three new blades and six to eight thousand to rebuild the generator, I quickly forgot about it. To me that's ridiculous.

Having worked in machine shops for more than 25 years, I feel I do know a little bit about some things. So now I suppose you can understand why I would be interested in any homebrew projects. Some time in the future I would like to try to build a hybrid electric vehicle from scratch. No kits. Maybe a Chevette or ? Well, that's my 2 cents worth for today. Marvin Cline, Martinsville, Indiana

Hi, Martin. We print a complete index to everything we have published yearly. The last one appeared in HP#53. This index is also available electronically on our web site (http://www.homepower.com).

If our industry was cranking out RE gear like Detroit was belching out cars, then the prices would be much lower. What you are seeing is the beginning of an energy revolution. Things are specialized and produced in small volumes, hence more expensive than your average consumer product. But a journey of a thousand miles begins with a single step. We are happy to have you with us on what will amount to a long journey. Mick and the Crew at Lake Michigan Wind and Sun could have made you new blades far cheaper and with your machine shop experience, I bet you could have fixed that Bergey! Richard Perez

Skiz Junkie
Print a booklet with all the schematics you have devised, e.g. tracker schematic, auto charge controller for battery charger, etc. A small booklet with all the ideas and working models that you have published in the past issues.

I want one! I'll pay of one and so will everyone else. When you decide to print one, please autograph my copy. Thanks, Sylvan Salem, Pagosa Springs, Colorado

How about it, readers? Are you interested in a booklet of Homebrew Projects from Home Power? If there is enough interest (let us know), then we will consider printing such a book. In any case, most of this information is on the current and even more on the upcoming CD-ROM. While we use CD-ROM, we realize that many folks don't. How about it folks? Richard Perez

Q&A

City System Design
Home Power has greatly enhanced my limited knowledge on renewable energy. I currently live in Houston and have acquired 24, 2 Volt, 840 Ampere-hour cells. Can anyone advise me as to designing a system to charge and use these cells—remembering that I'm in the city and there are restrictions on what I can build. Thanks, Billy Kasselman, South Houston, Texas

Wow, Billy, you have a large battery! I'd suggest configuring the battery for 24 Volt operation, you have enough cells since each series string will require 12 cells. This would give you two series strings of 840 Ampere-hours each for a total capacity of 1680 Ampere-hours at 24 VDC. Install a 24 Volt inverter/charger, such as the Trace SW4024, and you will have a perfect backup system for grid power outages. A battery of this size will require a big battery charger (a C/20 recharge rate would be around 84 Amperes at 24 VDC). The charger built into the Trace will have no problems recharging these cells using grid power. If you wish you can also install some PVs and/or wind power sources to recharge the battery from renewable energy sources. With the battery you already have and an inverter/charger, you have the makings of a large off-grid system should you ever move to the country. Meanwhile you will have uninterruptible electrical power even during extended grid failures. Be sure to get a licensed electrician to interface the battery/inverter system with the grid and your home's loads. Don't forget to make a secure and vented enclosure to house the cells. Richard Perez

Remote Door Opener
I've been off-grid since January 1978. I got my first panel in the Spring of 1981. My usual approach to solving problems is to try everything wrong first and then bump into the right solution. Before I do this again for the umpteenth time, I thought I would write you.

I have a Trace 4000 watt sinewave inverter and a new garage with an automatic garage door opener. Is there any way I can get my remote garage door opener signal sender to activate the garage door opener while the inverter is in the search mode? I don't want to leave the inverter in the "on" position all day just so I can activate the opener when I get home at night.

Right now I get out of my truck and use the walk in door of the garage to turn on a light, (the inverter is set to come on when there is a 30 watt draw), then activate the remote. It's easy to shut off because the light on the opener is designed to stay on for about five minutes after the opener is activated.

It seems like there should be a simple solution, but at this time, I can't see the trees for the forest. Thanks for your time. Charles R. McCarty, Malibu, California

Well, Charles, there is no simple solution to your problem. While the inverter is asleep, the garage door opener cannot listen to your radio command to open the door because it has no power to run its radio receiver. Your easiest option is to leave the inverter in the "on" mode all day. The Trace SW4024 will require about 16 Watts when idling. Other options are to modify the radio receiver in the garage door opener to run on 24 VDC power directly from the battery (difficult), or provide a more convenient 120 vac load (an outside light by the driveway?) to wake up the inverter and then activate the garage door opener. Leaving the inverter up and running all day will consume the energy produced by about half of a full-sized PV module. This is not a large amount of energy (about 160 Watt-hours). Consider adding another couple of modules (it has to be two modules since you are a 24 VDC system) and leaving the inverter on all the time. Most homesteads using inverters these days leave them running all the time. If it's not the garage door opener, it's the answering machine, FAX or whatnot which requires power. Richard Perez

Hydro Potential
I have been interested in water wheels to generate power with. I read quite commonly about little hydro systems and understand the potential generation capacity that they have. Are larger water wheels just not efficient? I think that a water wheel would be real neat looking operation rather than an automotive alternator in a box being fed by a water line. If there is some info somewhere I would like to know about it. Thanks. Rod Hyatt, Eden, Utah

We published a system article about an overshot hydro wheel as our cover story in HP#37. This article pointed out some of the problems encountered in large diameter, overshot hydros. The most difficult problem to overcome efficiently is the power transmission between the hydro wheel and the electrical generator or alternator. These big wheels move very slowly, typically less than 20 rpm. The alternator or generator likes to run at between 1800 rpm and 5000 rpm. Gearing up the power often involves losing about half (or more) of it in the process. Overshot wheels also tend to be very thirsty. While microhydro folks measure flow in gallons per minute, overshot hydro folks talk about cubic feet per second. Moving these quantities of water to the

wheel often involves substantial civil works such as big ditches or flumes. These are all reasons why we see so few hydroelectric systems using overshot, large diameter wheels. Richard Perez

Advanced EV Batteries

I am interested in light weight electric road vehicles, at least partially powered by photovoltaics. I need to know the name and address of the most advanced lead acid battery makers who will sell to an individual or a dealer who will do so. I need three or possibly four class 27, 12 Volt batteries: light in weight, long cycle life, deep discharge, high amp hours or energy density. I would like information on how to charge a 36V auto system with photovoltaics. My vehicles will be three wheel, front steer, 2 hp, two passenger "motorcycle." Mr Edward Proctor, New Holland, Pennsylvania

Check the battery ads in Home Power for a maker or dealer. You can recharge the 36 Volt battery from PVs by wiring three standard (12 Volt) PV modules in series. This will give you a 36 Volt array. If you need more current, then add another three modules in parallel with the first three. Be sure to wire a fused disconnect and a blocking diode into the PV/battery system. If the vehicle is to be left charging for periods of days, then adding a charge control will prevent the PVs from overcharging the battery. Richard Perez

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17. I certify that the statements made by me above are correct and complete. Karen L. Perez, Publisher and Managing Editor 9/26/96.

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