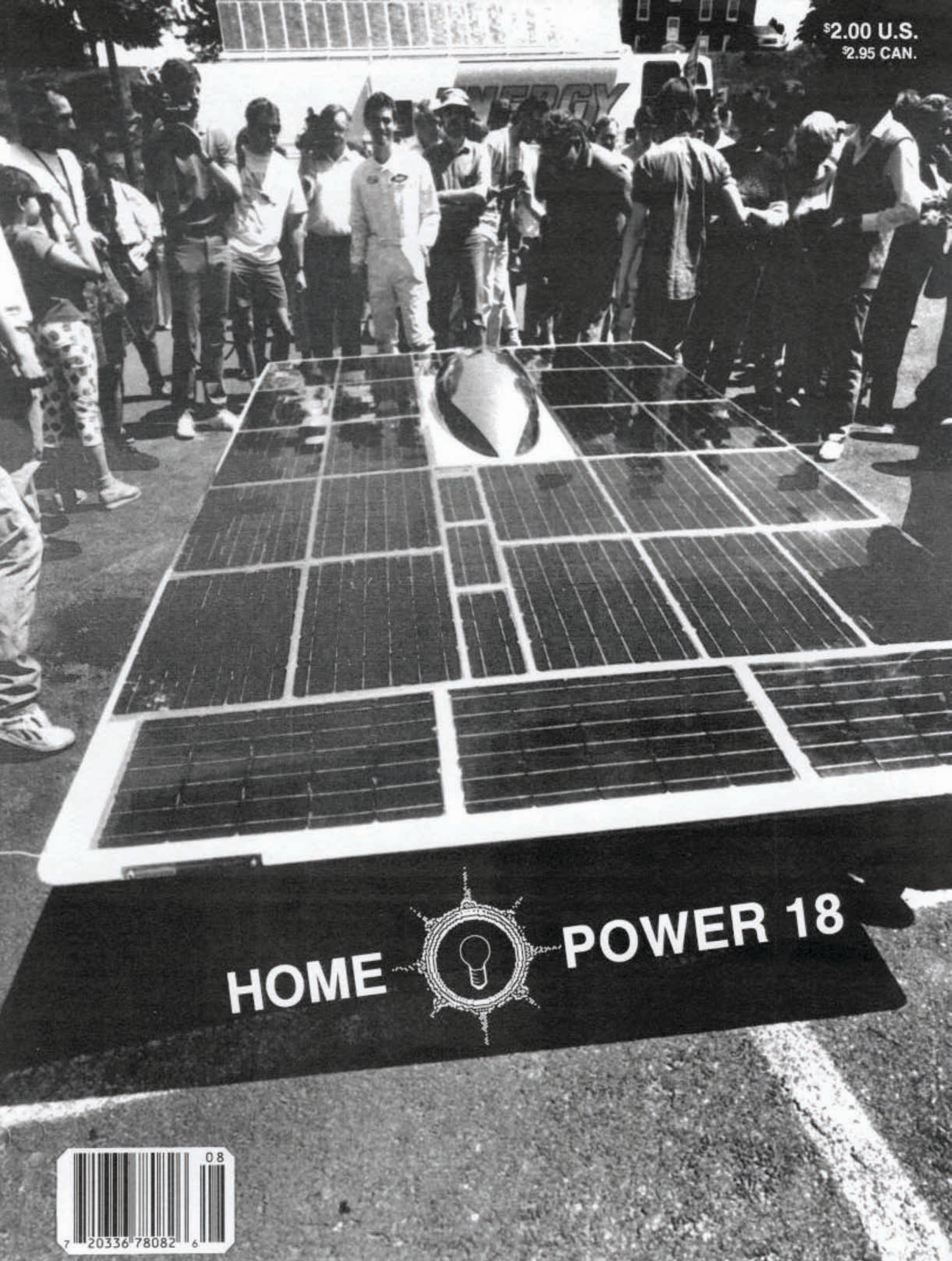
$2.00 U.S.
$2.95 CAN.



HOME POWER 18

Home Power

THE HANDS-ON JOURNAL OF HOME-MADE POWER

People

Albert Bates
Sam Coleman
Lane S. Garrett
Chris Greacen
Nancy Hazard
Scott Hening
Kathleen Jarschke-Schultze
Stan Krute
William Oldfield
David MacKay
Karen Perez
Richard Perez
John Pryor
Bob-O Schultze
Ann Schuyler
Wally Skyrman
Gary Starr
Toby Talbot
Michael Traugot
Larisa Walk
John Wiles

Issue Printing by
Valley Web, Medford, OR

Legal

Contents

Access

Home Power Magazine
POB 130
Hornbrook, CA 96044-0130

916–475–3179

Think About It

"Small is the number of them that see with their own eyes and feel with their own hearts."

Albert Einstein in The World As I See It - 1931.

Cover

MIT Solectria, the winner of the 1990 American Tour de Sol, collecting solar energy before hitting the road again.

Photo by Mark Morelli.

Energy Park at the 1990 Oregon Country Fair

Richard Perez

In the predawn hours of 12 July, the crew piled into packed trucks and headed north for the 1990 Oregon Country Fair. We were invited to put on a PV water pumping display (in the form of a Solar Fountain) at the Energy Park section of the Fair. It was a strange and wonderful journey into the very heart of the Green Dream.

Now, the Oregon Country Fair is unlike any fair, anywhere. This three-day fair, in its 21st year, has a permanent location that is more like a small town than the usual "set up for a weekend" fair scene. The Oregon Country Fair has streets shaded by large trees, permanent buildings (constructed by the booth holders & fair crews), and all traffic is only by foot. The Fair provides all the services that a town would normally supply its residents- water, waste disposal, traffic regulation, medical, and security. At this year's fair there were over 250 booths displaying hand made items (furniture, art, tools, clothing, musical instruments, you name it…) and over 50 booths serving up the finest in all types of food (no, make that cuisine at food prices).

Energy Park is a small section of the fair dedicated to practical, effective alternative energy technologies, including solar, wind, hydro and conservation. We were in good company. The Energy Park was a microvillage of energy folks. On hand were PV displays (from Free Energy Options & Electron Connection), hydroelectric displays (Harris Hydro & Lil Otto Hydroworks!), inverters (Heart Interface), PV powered refrigeration (Sunfrost), recycling (BRING Co.), PV powered fans (Alternative Energy Engineering), solar hot water heaters (Sage Advance- the Copper Cricket), thermal mass masonry stoves (Kachelofen Unlimited), solar cookers (Sustainable Energy Education Network), and permaculture (Tilth). The Energy Park also houses the solar heated showers where fair goers can clean-up for a buck-fifty.

During the weekend about 30,000 people went through the fair. Around 2,000 of those stopped by for a chat with the folks at Energy Park. We met many Home Power readers and swapped tech tales. Everyone was kept constantly busy answering questions from folks wanting info on renewable energy use. We distributed over a thousand issues of Home Power to ready readers

About all we didn't do was sleep. After the fair closed for the day, the thousands of folks putting on the fair could relax, eat, and enjoy themselves. Exhibitors and the Fair Crew were living on site during the fair. If all towns were like this one, then I would consider moving into one. The Fair Crew deserves high compliments for the most efficient, loving, and effective, large gathering I have ever attended. There was live music everywhere, all the time (even in the wee hours). Our particular favorites were the Kudana Band and the Shumba Band, both all marimbas, and Artis, the virtuoso of the spoons. There was so much to see and do that we only experienced a small fraction. Sleep? Well, time enough for that later.

We had a very good time and wanted to share this "high energy hit" with all HP readers. Know that there is hope. Know that you are not alone. From what we saw at the 1990 Oregon Country Fair, the Green Dream is very much alive and growing.

Access

Oregon Country Fair, POB 2972, Eugene, OR 97402. Our special thanks to our booth coordinator, Jude Hobbs.

"The Drums…

John Pryor & Karen Perez talk to fairgoers around the Solar Fountain. The hardware used in this fountain (two Kyocera PV modules & a Solarjack SDS submersible pump) can pump about 300 gallons daily from a 200 foot deep well.

Fairgoers gather around the Home Power booth. We answered hundreds of questions about renewable energy during the three day fair.

THE DRUMS… T H E Y

Perhaps the best parts of the fair were the people and sharing our experiences.
Above: Don Harris explains his wonderful hydroelectric machines.

Above: The Solar Showers kept Energy Park people clean and smiling. Free information about all types of renewable energy production and use were distributed here.
Left: Karen Perez having fun at the Home Power booth.
Right: Kathleen Jarschke-Schultze takes a break to make a basket in the shade of the booth.

Solectria Lightspeed, winner of the 1990 American Tour de Sol, at the starting line.
Photo by Toby Talbot.

Solar Cars Come of Age:

SOLECTRIA LIGHTSPEED WINS 1990 AMERICAN TOUR DE SOL

Nancy Hazard

Northeast Solar Energy Association's (NESEA) 1990 American Tour de Sol, the American Solar Car Championship, was a great success. There were 15 entries from across the country, each unique, pushing solar electric vehicle technology to the limits. This second annual five day event was held from May 23 to 27, 1990. It involved 234 miles of travel and fourteen solar car exhibits from Montpelier, Vermont to Boston, Massachusetts. Besides numerous vehicles from colleges, universities, and one high school, the event attracted 3 conventional-looking solar production prototypes which were enthusiastically received by spectators and the press and made competition very stiff. Their designers hope to have them in production by the end of the year.

Solectria's Solar Racing Team of Arlington, MA was the clear winner of the commuter category, as Anita Rajan drove the Solectria Lightspeed, a sleek two seater sports car, across the finish line. The car and team has been sent to compete in the Tour de Sol world championship in Switzerland. Travel has been provided by Lufthansa German Airlines. Solectria's Sunrise, a four seat vehicle, finished only a few minutes behind, followed by Tufts University in third place. Fourth, fifth and sixth places were claimed by Delta College, Michigan's S-CAR-GO, the Sundriver Model D from Tennessee & New Hampshire Technical Institute's Sungo, respectively.

In the Tour de Sol racing category, the MIT Solectria 5 was driven to victory by James Worden, veteran solarmobile driver and principle of Solectria Inc. He was followed by the Dartmouth College's Sunvox II, the New Hampshire Technical Institute Suntech II, Conval High School's Sol Survivor, Champlain College's Vermont Sunrunner, and the University of Lowell's Sun Blazer.

The University of California at Irvine, the sole entry in the Cross Continental Category was declared the winner of that category, while the open category attracted two interesting entries, an electrified mountain bike entered by team Rosebud from Barre, Vermont, and a hybrid solar electric/gasoline car by Solar Car Corp. of Melbourne, Florida.

Solar Car Corp's Car was beautifully crafted using a 1984 Honda Civic body, Astro Power solar cells, a DC motor, and a small gasoline driven motor with a half gallon fuel tank. the gasoline motor is used to extend the range of the car, and can either run a generator to charge the batteries or be mechanically coupled to the drive train for highway cruising. Doug Cobb, principle of Solar Car Corp., has plans to produce this car by the end of the year, and to develop several other smaller models with increased driving ranges. If the car he brought this year is any indication, he will be a very strong contender in the 1991 American Tour de Sol.

Solectria's Lightspeed, on the other hand, has an innovative AC Synchronous motor, which was jointly designed and built by James Worden of Solectria, and Uniq Mobility, Inc. The power (25 Horsepower peak), simplicity, light weight and efficiency of Solectria's motors are a significant technological advance. Solectria's cars can be ordered from Solectria Inc of Arlington, MA.

Another car of note was the New Hampshire Technical Institute's "Sungo", a converted Yugo. Conversions have the obvious advantage of starting with a safe, acceptable body, suspension, brakes and wheels. In this case a 3 phase industrial AC induction motor was used. Although last in the commuter standings, the Sungo was recognized as an outstanding effort by race director, Dr. Robert Wills.

The Northeast Solar Energy Association (NESEA) of Greenfield, MA organized the race to foster the development and use of solar electric vehicles for everyday use. Solar/electric vehicles have photovoltaic panels, batteries and electric motors instead of gasoline engines. "They are quiet, can travel up to 70 miles per day at normal road speeds, and are totally pollution free when running, and so are a real answer to our city air pollution problems." said Nancy Hazard, race co-director.

The American Tour de Sol demonstrates that solar electric vehicles are a viable transportation option today. Solarmobiles could also have a significant impact in reducing acid rain and global warming by eliminating pollution from automobile exhausts, which are the main contributors to these environmental problems. (see attached addendum)

The limiting factors in solar electric vehicle design are the cost of photovoltaic panels and the energy density of batteries. Photovoltaic panels,which convert sunlight directly into electricity, have become significantly cheaper and more efficient but government funding for research has dropped steadily since the 1980's. "It is time to renew our support for photovoltaic and battery research and invest in our own and the world's future" said race co-director Dr. Robert Wills. While esoteric battery technologies such as solid lithium, molten sulphur and zinc-air show promise, most vehicles in the American Tour de Sol used conventional lead acid batteries.

The American Tour de Sol is sponsored by Lufthansa German Airlines, New England Electric System, and US Department of Energy as well as many other people and organizations who are concerned about the environment.

NESEA plans to run next year's race through southern New England, from Albany NY, to Hartford CT, Providence RI and Boston MA. For more information, contact NESEA at 23 Ames St., Greenfield MA, 01301 (413) 774-6051

1990 American Tour de Sol Results

Place	Team	Car Name	Driver(s)	Lap Miles	Total Miles	Route Time (Hrs.)	Adjusted Time (Hrs)
Commuter Category							
1	Solectria	LIGHTSPEED	Anita Rajan	79.9	312.4	9:26:17	8.19
2	Solectria	SUNRISE	Andy Heifitz	47.2	279.7	8:58:18	8.24
3	Tufts University	Sun on Hill 1	Nagi Koudoli, Van Toi Vo	20.4	252.9	20:06:11	19.89
4	Delta College	S-CAR-GO	N/A		169.5	11:59:10	40.39
5	Sundriver	MODEL D	Darrell Murphy		181.8	8:35:44	46.50
6	NHTI	SUNGO	N/A	1.6	75.6	6:28:44	62.85
Tour de Sol Racing Category							
1	MIT Solectria	SOLECTRIA 5	James Worden	71.3	303.8	7:18:36	6.19
2	Dartmouth College	SUNVOX II	Rob Rennie	27.2	259.7	8:17:44	7.90
3	NHTI	SUNTECH II	N/A	20.4	252.9	10:05:31	9.88
4	Conval High	SOL SURVIVOR	N/A		232.5	14:58:14	40.32
5	Champlain College	VT SUNRUNNER	Greg George, Donald Hill		192.5	16:34:25	40.91
6	U of Lowell	SUNBLAZER	N/A		27.3	1:20:33	73.74
Cross Continental Category							
1	U of California- Irvine	SOLARIS II	Biutler, Choi, Young		184.8	14:39:42	53.41
Open Category							
1	Solar Car Corp.		Doug Cobb, Todd Hare	8.2	240.7	10:07:41	9.99
2	Team Rosebud		Paul Butler		224.2	20:24:54	25.42

The Automobile and Our Environment:

Many people have not made the connection between the automobile and environmental degradation, but the facts are:

* Ground level ozone smog is caused mainly by auto emissions, and poses the most serious health problem in the US. (American Lung Association)

* 90% of the air pollution in cities and 30% of the greenhouse gasses come from fossil-fueled transportation (source: Environmental Action, EA, July '89)

* The earth will run out of oil reserves in 30-40 years.

* Transportation consumed 68% of the oil used in the USA in 1988, half of which is used in personal vehicles. (EA)

* Burning 1 gallon of gasoline yields 22 lbs. of carbon dioxide (the major greenhouse gas). a car @ 27 mpg yields 37 tons of carbon dioxide in its expected lifetime (@ 45 mpg=25 tons, @ 18 mpg=57 tons) (EA, July '89)

*Estimates of the increased health care costs of diseases caused by air pollution, such as emphysema, lung cancer, heart disease and lead poisoning, are $1 for each gallon of fuel burned in an automobile, or $133.8 billion annually in USA (Veziroglu, quoted in Omni Magazine July 89)

* Annual environmental costs of using fossil fuel in the US "range from $4.4 billion spent on land reclamation necessitated by strip mining, to $73 billion damage caused by leakage from underground gas tanks, and another $8.2 billion is lost in farm produce due to ozone and acid rain". (Omni, July '89)

* Other alternatives such as methanol, ethanol and compressed natural gas produce less emissions and carbon dioxide than conventional gasoline automobiles, but the savings are only in the 20-50% range. (EA, July '89)

* Electric cars are non-polluting at the tail pipe. The electricity generated to recharge their batteries end up putting 70% less carbon dioxide, 90% less nitrous oxide, and 99% fewer hydrocarbons and carbon monoxide, per mile, into the atmosphere than gasoline-powered vehicles. (Electric Power Research Institute, EPRI, based on the mix of power plants presently in use.)

* Electric rail travel, compared to gasoline auto travel, reduces hydrocarbon and carbon monoxide emissions by 90%, and nitrous oxides by 50% ("Mass Transit: Clean Air Alternative", a report by the American Public Transit Association.)

* If 30% of all the miles traveled by automobiles in 1988 had been traveled in solar cars, the USA alone would have saved 500 million barrels of oil. (assuming 30 mpg) (NESEA)

Solar Car Corp's hybrid car from Melbourne, Florida is a solar electric auto with a gasoline engine as a range extender. Pictured here as it crosses the finish line during the 1990 American Tour de Sol.

Photo by Toby Talbot.

The Lectric Leopard with a solar battery charger.

The Shocking Truth About Electric Cars

Gary Starr

According to recent studies, 90% of all second car driving is under 21 miles per day, and 75% of the daily travel in the United States is within 31 miles of all driver's homes. Today, electric cars are capable of speeds of 60-65 miles per hour and have ranges of 50 to 100 miles.

In the year 1900, there were more electric vehicles on the road than gasoline-powered cars. In a little remembered trial in 1949, General Motors, Standard Oil of California, Phillips Petroleum, Mack Manufacturing and Firestone were convicted of antitrust violations for their activities in buying and dismantling electrified-rail mass transit systems.

Electric cars never need gasoline (just think, no more gas spills on either your car or yourself!). They also don't produce any exhaust pollution whatsoever. Conventional cars have been blamed for producing up to 50% of the greenhouse effect, and are largely responsible for urban smog. Electrics also produce much less noise pollution. They are much quieter during normal operation and during idle are nearly silent.

In order for gasoline powered vehicles to operate efficiently, they need to be warmed up and driven at steady speeds. They are extremely inefficient when used for short trips, stop and go city driving and in traffic. This inefficiency results in poor burning of fuel and the production of air pollution. Electrics can perform very efficiently during short trips, since their motors don't need to be warmed up, and when the vehicles are rolling to a stop or a standstill no energy at all is consumed.

If an environmentalist drives a gas powered car, he could be as guilty a polluter as an errant oil tanker. A recent Greenpeace article (May/June 1990) noted: In the United States do-it-yourself auto mechanics dump an Exxon Valdez worth of used motor oil down drains and sewers every two and one-half weeks. Drivers in Los Angeles use one of every four gallons simply idling their cars on traffic-bound roads. The amount they send up in smoke is 80 times greater than the amount spilled from the Exxon Valdez. This waste will only get worse as congestion clogs roadways and driving speeds slow. Analysts predict that average speeds in Los Angeles will drop from 35 mph today to 15 mph by the year 2000.

ELECTRIC = SAVINGS

In regard to maintenance and operating costs, electrics are much less expensive to own than conventional vehicles. Electrics cost only 1.9 to 4 cents per mile. (.38 to .77 kiloWatt hours per mile). Recently US News and World Report noted that the average cost per mile for gas cars, just the gas & oil used, was 8 cents per mile.

Additional cost savings can be achieved by charging a vehicle during off-peak periods using a dual metering system available through your utility. Once the meter is installed rates go down if the vehicle is charged between 6 p.m. and 12:00 noon.

Electric vehicles never need oil changes or radiator flushes. They never need tune-ups, antifreeze, or carburetor adjustments. They have no mufflers, sparkplugs, valves, fuel pumps, fan belts, water pumps, pistons, radiators, timing belts, condensers, points, or grinding starters. They have no need for PVC valves, or catalytic converters, and never need smog tests.

One additional area of savings in power, maintenance, and possible tax savings is the addition of solar panels. Solar panels can extend vehicle range, reduce charging time, and extend battery life.

It is possible that if solar panels are integrated into the vehicle, the entire vehicle will qualify for both the Federal and California's business solar tax credits, totalling 20% of system cost.

WHAT NEGATIVE IMPACTS?

Some critics of electrics have claimed that new power plants would need to be built, trading one pollution source for another. These claims appear to be false. Southern California Edison claims it currently has enough slack nighttime capacity to recharge 600,000 electric vehicles in its service area. The results of a utility survey prepared by Electric Vehicle Development Corporation (EVDC), showed that by the year 2000, 3.4 million EVs could be served by off-peak capacity by the utilities which responded to the study. By extrapolating the data for the entire U.S., EVDC estimates that some 19.7 million EVs could be served nationwide with projected off-peak electricity generating capacity.

Others have expressed worry that these vehicles would also contribute additional pollution from power plants. According to the California Air Resources Board, electric vehicles emit 90% fewer pollutants than gasoline even after including emission from the power plants. Furthermore, on the west coast much of our nighttime power comes from hydro, and with continued price breakthroughs in solar electricity, the availability of pollution free electricity may be unlimited.

DINOSAURS IN DETROIT

Despite a recent unveiling of an electric car by GM, Detroit car makers seem to have a bias against electric vehicles. It seems that their token efforts have been designed merely to becalm lawmakers intent on adopting tougher pollution control standards.

In a recent interview about the electric auto, Roger Smith, Chairman of General Motors cautioned that their electric car, the Impact, "would cost twice as much to operate as a gasoline-powered car." This statement is directly contrary to data generated from both private and government studies.

Last fall, just months before Earth Day, General Motors employees received a letter from company president Robert Stempel urging them to write their legislators requesting that motor vehicle standards not be made any more stringent. Calling the industry already "at the very edge of technological feasibility," he says news reports about air quality in our cities are "exaggerated". Stempel also writes that California's new proposed air quality standards are "excessively stringent and unnecessary," and they "will divert our efforts from meeting the competitive challenge and our customers' needs."

Chrysler, usually the self-proclaimed innovator in Detroit recently bashed electric cars. At a recent press conference Lee Iacocca said, "Electric cars. Forget it. Everyone's putting new skin on a golf cart. Will people pay a premium to say, 'My tailpipe's cleaner than your tailpipe.' No."

"I hate to be a cynic," Iacocca said, "but GM says the car has a 125 mile range before recharging. Unless they have a secret, we say it's really 85 miles and if you floor the pedal to get uphill you lose half the range."

AIR POLLUTION NEARLY ELIMINATED

Statistics show that if we replaced 1 million gasoline cars with electric cars, total emissions would be reduced by 150 million tons a year. According to PG&E, an electric mini-van would produce 85% less ozone producing emissions and 97% less carbon monoxide than a gasoline powered mini-van. Tests conducted by the California Air Resources Board in May 1989 combined with PG&E's annual off-peak electricity generation - electric vehicles reduce emissions of HCs by 99%, NOx by almost 80%, and CO by 97%.

GAS GUZZLERS & OIL ADDICTS

According to the department of Energy, the transportation sector consumes 62% of all petroleum consumed in the country,10.7 million barrels per day. Motor vehicles consume 7.31 million barrels per day of petroleum, or 41% of all oil consumed in the country.

Currently, the Federal government is pushing for more off-shore oil drilling in fragile and pristine areas such as off the Northern California Coast and the Alaska National Wildlife Refuge. But calculations indicate that if only 1% of the vehicles on the road were electric and those vehicles were driven 10,000 miles per year, we could conserve 500 million gallons of gas in just 12 months.

In 5 years the savings would be 2.5 billion gallons. If one keeps in mind that it takes two gallons of crude oil to distill one gallon of gasoline, the actual oil saved would be 5 billion gallons.

THE HEALTH HAZARDS OF OIL AND GAS POWERED CARS

According to Dr. Samuel Epstein, Professor of Occupational and Environmental Medicine at the University of Illinois Medical Center, cancer is now the only major killing disease in the industrialized world with sharply rising rates. There are over 900,000 new causes and 450,000 U.S. deaths each year. Americans now have a one-in-three chance of developing cancer and a 1 in 4 chance of dying from cancer.

Dr. Epstein believes that there is very persuasive evidence that the use and manufacture of petrochemicals are the major cause for the recent rise in epidemic cancer rates, and that the relatively low retail price charged the U.S. taxpayers for gasoline totally fails to reflect hidden costs. He notes that apart from strategic and security costs of dependence on foreign imports, the environmental and health costs are prohibitive. They include:

*Leukemia and cancers among refinery workers and neighboring communities.

*Cancer, respiratory and cardiovascular disease from exhaust emissions from both vehicles and commercial plants.

*Leukemia and cancer from excess benzene during refueling. (Note: Consumers are routinely exposed to 1 part per million during full service gasoline refueling and 3 parts per million at self-serve pumps. That exceeds the 1 part per million standard above which the Occupational Safety and Health Administration requires that workers be warned and protected.)

*Liver and kidney cancers related to evaporation and inhalation of unleaded gasoline due to the isoakenes in gasoline.

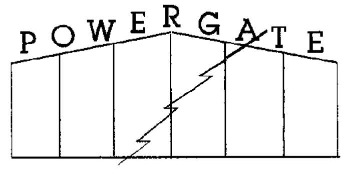
*Respiratory disease, particularly in the young and elderly, due to aromatic hydrocarbons, especially xylene.

In a recent editorial (LA Times, 1989), the doctor summarized his position by stating, "the multi-national petroleum industry is a reckless corporate citizen that holds the world for ransom. Time and again, when a choice between profit and human health or the environment or national security must be made, the industry will choose profit every time."

Electric vehicles are a reality and are available today. Vehicles range from a $900 electric bicycle to a $20,000 luxury sports car. Several models are available for under $10,000 that are capable of carrying four adults. All the vehicles can be recharged simply by plugging into any standard 120 volt ac outlet. Some may also be adapted to solar trickle charging. An information update and an evolving list of available vehicles may be ordered for $30.00 per year from Solar Electric, 175 Cascade Ct., Rohnert Park, CA 94928, or by calling (707) 586-1987.

ACCESS

Gary Starr, President of Solar Electric has been driving, researching, and marketing electric vehicles for the past 16 years.



The State of the PV Industry

Lane S. Garrett

The decade of the 80's saw price reductions faster than expected by industry "experts" in the sales of photovoltaics (PV for short). Costs of a PV module or a certain amount of power is normally measured in terms of dollars per peak watt or, $/Wp. This is the output of a module, with an ideal load, in Watts under full sunlight defined at a strength of 100 milliWatts per square centimeter. PVs sold in the early '70's were over $50/Wp and had dropped to $12 - $15/Wp by 1980. By the end of 1989, a shopper could buy quality PV power for just under $6/Wp. This is equivalent to over a 5% drop in price per year; if inflation is considered, this amounts to about 10% per year in real dollars!

1989 was a first for the PV industry, when average selling prices from the manufacturers actually increased slightly! This stabilized prices in the industry and brought most factory costs to a break-even or profitable level. With demand currently outstripping capacity, most of the manufacturers are backlogged up to 3 months delay for some products. Manufacturers are rapidly expanding facilities and even planning new plants. With this significant improvement, the financial community is beginning to look favorably on the PV industry. Maybe the banks will learn how to pronounce photovoltaics, and make loans available at good rates. After all, a PV system costs about the same as a new car, and lasts a few times longer.

PV system sales went from several million dollars a year in 1980 to an estimated .5 billion dollars in 1989. If the industry can hold last years growth rate, (about 35% to 37%), system sales will reach 20 billion dollars by the turn of the century.

What does all this mean for us as potential users? Simply, as industry volume increases, average selling prices will continue to drop to about $3.50/Wp in constant 1989 dollars. On the other hand, utility prices will continue to increase at an estimated 6% per year. Thus $.10 per kW-Hr climbs to $.18/kW-Hr in 1999.

Compared to gasoline generators, PV has been considerably more cost effective over the last decade. Total costs of PV, including all maintenance costs, are now about 25% of fossil fuels over a 15 year period. Also PV has been the choice for over all reliability from mountaintop communications to water pumping for cattle.

In the next decade, you will see PV power inside the utility grid in numerous applications. Reasons for this new PV territory are numerous. Powering your pool circulation pump with PV, for example, gives an after tax return on system cost of 12% to 14%. This is a better use of money than available elsewhere. Intercity street lights, bike path lighting, bus shelters, etc. are often lower in cost using PV than connecting to the utility. Also PV costs are now such that a well designed solar home employing high efficiency appliances is cost effective. Electrical independence requires an increase of about 15% in the mortgage payment. (Many families already have Utility bills exceeding 15% of their mortgage). An increasing number of families are desiring to own rather than rent their electricity.

Europe has become fed-up with the disastrous results of acid rain and is moving rapidly toward renewable energy sources (especially PV). This trend should move to the U.S. over the next year or two as the public becomes more environmentally aware. Experts state that the true cost of our electricity is 50% to 100% higher when we assess the true environmental impacts of pollution, acid rain, and the warming trend due to the Greenhouse Effect.

We have an important role to play in getting the word out to the general public; that photovoltaic power when coupled with reasonable conservation is a viable alternative to using fossil fuels; that PV is already cost effective in many applications; and PV does not pollute our environment. Many don't realize that PV modules now have a life-time equivalent to the windows in their homes. The PV will still be making power long after the mortgage is paid off. By working together we can make a difference through our purchasing vote and helping to educate our friends and acquaintances.

Access

Lane S. Garrett, P. E. C.E.M., SunAmp Power Company, POB 6346, Scottsdale, AZ 85261 • 602-951-0699.

The sloop Longhope is powered by photovoltaics, a home made windmachine, a home made hydro and two engine/generators.
Photo by Willaim Oldfield

Alternative Power on a Cruising Sailboat

William Oldfield

A cruising sailboat is the ultimate application for alternative power. There is no power utility. Fuel has usually to be carried from a gas station. Even water has to be loaded jug by jug! One approach advocated for cruising is to revert to a pre-industrial lifestyle using little electrical energy. This involves oil lamps, dried food and few instruments. Many hardy sailors can manage this approach and sail without many creature comforts. We feel safer with modern instruments and enjoy amenities like fresh food. Our sailing lifestyle can be supported by extracting the necessary power from the sun and the wind.

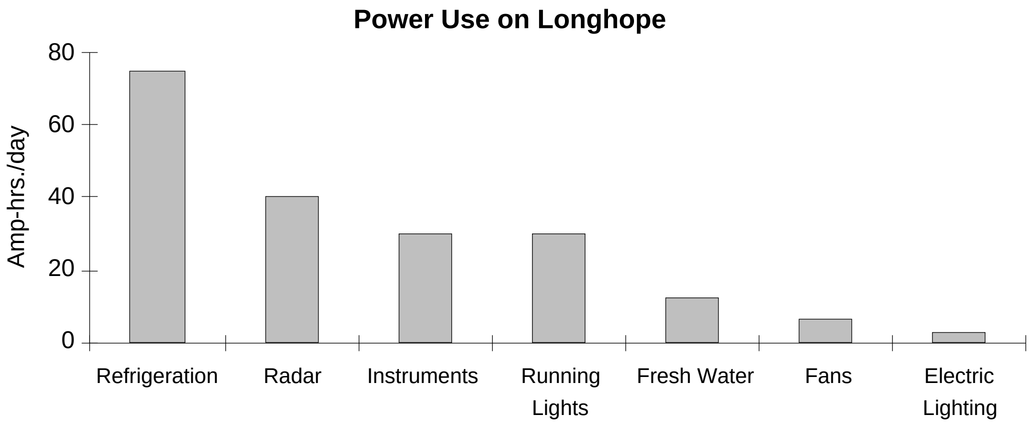
Cruising in a Sailboat

We sold our house in 1986 and sailed for Mexico. Since then, we have cruised in our 36 foot sloop, Longhope, in the Sea of Cortez and off the Mexican coast as far south as Zihuatenejo. We started like most sailboats. The main engine supplied most power, supplemented by a 600 watt generator. This was not very comfortable since running the engine makes the ship noisy and hot. Running the generator is even noisier. Now, the main engine supplies power only when we also need it for travelling in light winds, topping up the batteries and providing additional power for the water maker at the same time. The generator mainly serves as a 120 vac power source for power tools. Alternative power preserves the surroundings and provides a cooler and more peaceful living space.

What follows is a semi-technical description of our electrical evolution. The photo shows Longhope at a mooring in San Carlos, Sonora. The wind generator can be seen hoisted behind the mast, above the boom. The solar panels are just visible mounted on a rack above the Bimini cover.

Energy Demand and Supply

The way to develop alternatives to conventional power supplies is to first understand the power consumption demands of the equipment, then find the possible sources of supply. The main consumer on Longhope is an Adler-Barbour fridge unit which we added to the 9 cubic foot ice box. The other major consumer is a Recovery Engineering reverse osmosis unit which makes about 1.4 gallons of fresh water an hour. The key energy requirements are shown in the



Power Use All loads 12 VDC	Amps Used	Hours Running	Amp-Hrs Used Daily	Comments
Creature Comforts				
Electric Lighting	1	3	3	Inside the cabin
Refrigeration	5	15	75	Varies with temperature & fridge setting
Fans	1	6	6	Used to circulate air in hot weather
Fresh Water	4	3	12	Water loaded from shore when possible
Sailboat Operation				
Instruments	3	10	30	Used only when sailing
Running Lights	3	10	30	Used only when sailing at night
Radar	4	10	40	Mainly used at night
Total Ampere-hours Used Daily			196	

table below. Since it is sunny most of the time in Mexico, the major supplier of power is the PV panels.

Solar Power

Our panels consist of two Arco M75 and two reconditioned Arco 16-2000 panels. One difference between a boat and a land installation is that a boat points in any direction. Because of this, we mounted the panels horizontally, causing loss of efficiency. The geographic latitude causes about 10% loss in our latitudes (the panel should be tilted south in the northern hemisphere). Because the panels do not actively follow the sun across the sky there is a further loss of efficiency. We obtain about 64% of the energy collected by an active panel if the day length is 12 hours. Despite these losses, we get about 62 Amp-hours on a normal sunny day.

Wind Power

We bought parts for a wind generator from a longtime cruiser, Fred Turrentine of the trimaran Serape. He has supplied about half the generators used on sailboats in this area. The parts supplied to us were a used computer tape drive motor fitted with an arbor to hold the propeller, a diode and a 60 in. propeller. The design of my completed unit is shown in the illustration. The motor and propeller were fastened to a piece of broom handle using four hose clamps. They were wrapped with tape to cover the sharp edges. The fin was cut from a piece of black plexiglass. A piece of 1/8 in. nylon braid was attached near the fin, long enough to be reached from the deck to stop the generator. Two "V" arrangements were made out of 1/2 in. nylon rope with a metal thimble at the tip of each "V" to avoid chafe. One was mounted inverted above the broom handle, the other below. The "V's" were not quite symmetrical. The attachment points, the thimbles, were skewed forward to lie above and below the center of gravity of the system. The ropes were tied to the motor and the wooden rod (I spliced bowlines on the ends and the unit hung in the loop) and locked in place with plastic cable ties. The top attachment could then be clipped to the line normally used to raise the mainsail and hoisted as high up the mast as necessary for safety. The lower attachment point was fastened to three lines. Two were tied to the grab rails at each side of the cabin, the third to the end of the boom. Lengths were adjusted to pull the generator away from the mast and give it a slight downward tilt. The whole was winched tight by the main halyard.

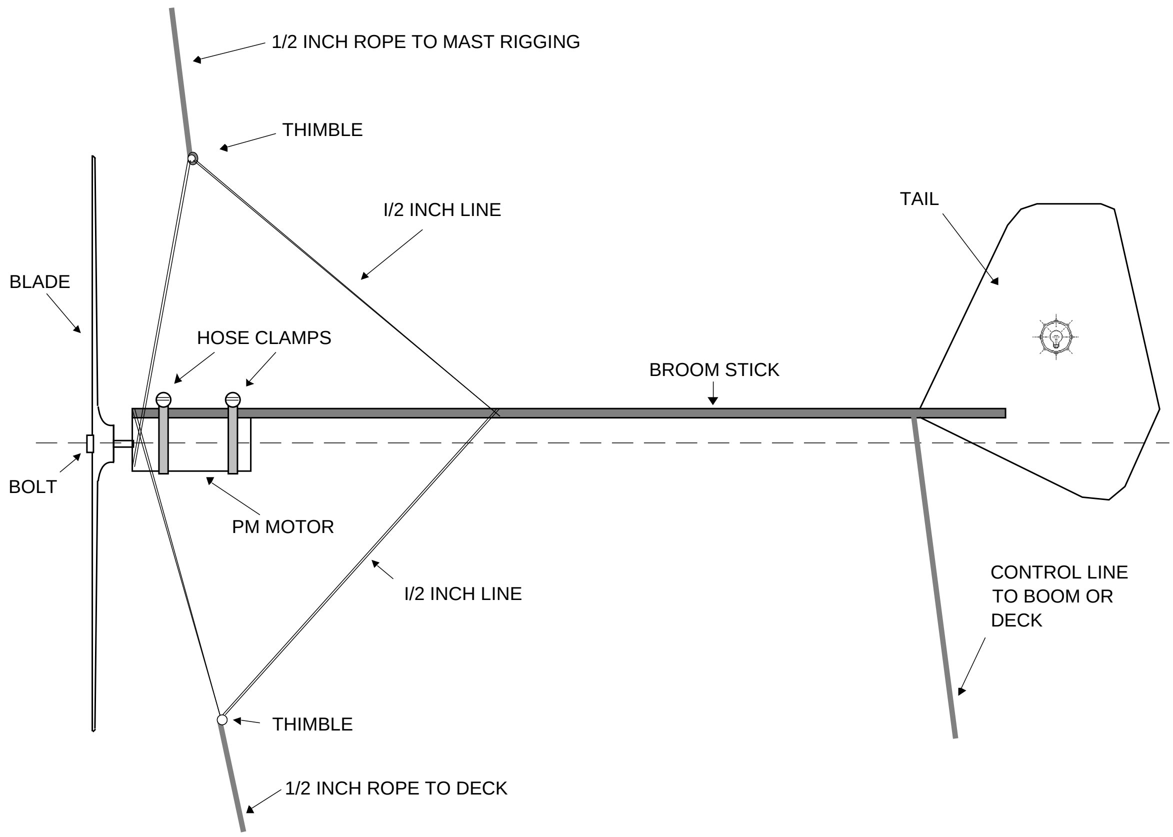
A two conductor 16 gauge stranded cable was used to link the generator to the ship's electrical system. The diode was mounted to a heat sink on the positive line. A switch was installed to short circuit the positive and negative leads (on the generator side of the diode of course). Shorting the system provides instant braking. In any reasonable wind, the generator should first be tilted out of the wind using the cord attached near the fin before the brake is switched.

The original propeller was damaged within two weeks of buying the system. The halyard was not tight enough and the spinning propeller hit another line running down the mast. This forced me to design and build my own. I have since carved several which have been highly successful. That is, they are quiet and give at least as much power as the original. Propeller carving is fairly easy -I carved the first with a chisel on a beach in three afternoons.

The wind generator makes more than 1 Amp in winds of about 10 knots or above. At 14-18 knots it generates about 10-14 Amps. One night when the winds were above 20 knots it reached 26 Amps. Under breezy conditions the wind generator can supply large amounts of power.

Water Power

Long trans-ocean crossings are an extreme situation. For example, a crossing to Hawaii may take as long as 30 days. The fuel supply is limited, and cannot be used to run the engine except under special conditions. The wind generator cannot be hoisted. PV power may not be adequate, particularly in overcast conditions. Fortunately, water power can fill energy needs. The boat speed



averages about four knots under sail and a towed propeller can produce a steady 4 Amps, (90-100 Amp-hrs.). Supplemented by PV, this is sufficient for the instruments, lights and the refrigerator.

A suitable unit has a 2 hp outboard motor propeller linked to a DC motor (such as the wind generator motor) and towed about 50 ft.behind the ship on 1/2 in. nylon braid. The propeller is mounted backwards on a 36 in. long stainless steel shaft to keep it below the water surface. Provision must be made to protect the bearings of the generator from the load of the propeller drive system and for easy disconnection of the line. Better carry a spare propeller. The unit on a friend's boat was attacked by a shark!

Engine Alternator

I fitted our engine with an Automac by Spa Creek. It provides a field current to the coils of the alternator which is adjusted using a solenoid to give an almost constant charging voltage. It cuts out (to the standard voltage regulator) when the voltage reaches a value preset by the user. We limit our charge rate to 30-35 Amps, at which level the alternator does not overheat. We charge to about 13.8 Volts.

Portable Generator

We have a 600 watt Yamaha unit. Although it works well, it has not proved too successful as a power source for us. We used to run it for four hours at a time and the noise and heat was intolerable in the confined space of the boat. Its best application was to start the main engine on the two occasions when the batteries were flat. It now mainly provides 120v power for tools.

When the Yamaha is used for recharging batteries, we connect the 10 Amps/12v DC line into the batteries. The 120v is plugged into a battery charger charging the batteries at 25 Amps. The charger's circuit breaker trips after about 10 minutes if the charge rate is above 15 Amps. Cutting in and out, it takes a long time to recharge the batteries. As the batteries refill, the charge rate slows to a trickle. A smaller version of the Heliotrope HC75 battery charger recently reviewed in HP17 would make this Yamaha generator a really viable recharging option for our boat.

Power Storage

Battery management has been the major failure of our energy system. We have had to replace all our batteries three times. The last set, expensive sealed gel batteries, only lasted about 8 months. The best so far have been Mexican automotive batteries which give far less stored power but stand up to abuse better.

Our major limitation is night travel. We need sufficient power when sailing at night for radar, instruments, running lights and the refrigerator. This requires a minimum of 130 Amp-hr of battery storage. Our design at the outset called for four model 29 batteries (ostensibly over 100 Amp-hr.) in addition to the engine starter battery. This has rarely worked properly. Our battery system always seems to be below specifications and needing replacement.

The reason for our failure lies in our inability to maintain batteries, particularly when we have left Longhope in Mexico during the hot summer months. Leaving her on marina dock power for three months destroyed one set. A boat sitter who left the batteries flat for two weeks destroyed another. A set of sealed gel batteries were destroyed because I left two solar panels charging them while away for a month. (I figured five batteries, four house and the engine starter, could handle a trickle averaging only 1.5 Amps. I believe the gel cell batteries were overcharged to failure).

Part of the problem lies in our poor choice of batteries, too fragile for the harsh cruising environment. The 6 Volt Trojans which were our initial choice and would have performed better, but they are too tall to fit in the available space. Six volt batteries are a problem in any case. Space forces us to have three batteries in one location and one in another, thus complicating the wiring of the system.

Alkaline batteries would be perfect. They are resistant to both overcharging and heat- our two main failure problems. Unfortunately, we seem to be driven by events and install what we can get or afford at the instant our old batteries die. Since it is not practical to mix the acid and alkaline batteries, we would have to take out four good batteries and replace them all by alkalines.

Our best investment would be a better voltage regulator system allowing the batteries to be recharged quickly and floated for long periods, all without damage. The main difficulty stems from the different power sources we use. This regulator would either have to regulate each power source seperately, or the system as a whole. Solar power is relatively easy to regulate. PV regulation is best accomplished by series type regulators which intermittently disconnect the power source from the batteries. Regulating the wind machine is more difficult since the load cannot be disconnected during strong winds without possibly causing damage by overspeeding. A shunt style regulator would hold the battery voltage in line regardless of the power source. *(See Homebrew, this issue for a schematic of just such a beast. RP)*

Last Words

Longhope's power systems have progressively improved. When our batteries are working we never have to start engine/generator just for power.

The most successful has been our PV array. It generates power with the minimum of trouble. It is exciting to realize that PV arrays with three times the power exist now. They use gallium arsenide in addition to silicon. I hope that future developments will make the better panels economically viable.

Access

William Oldfield, 1109 S. Carol DR., Flagstaff, AZ 86001 • 602-779-0506.

Longhope with the wind generator up the rigging.
Photo by William Oldfield

The SOMA 300 Watt Wind Generator at home in New Zealand.

Remote Area Power Systems in New Zealand

David MacKay

New Zealand lies in the south-west corner of the Pacific Ocean and is situated between 35° and 45° south latitude. The sub-tropical land, about the size of California, with 3 million people, has a significant proportion of remote areas. Despite the extensive mains power development in New Zealand, there is a considerable need for independent power systems in isolated areas. With favorable climate conditions, the development of wind technology for Remote Area Power Systems in New Zealand is well advanced. A wealth of experience has been obtained in system design and installation for home power including the use of solar, photovoltaics, batteries, inverters, microhydro, and low energy lighting.

Discussed here are just a few of the things that have been happening in New Zealand. When a place is a little bit out of the main stream, development and innovation can sometimes go off on a tangent from industry norm. There are not so many guidelines to work from and integrity can take its own undirected path and often come up with some exciting stuff.

HYBRID WIND SOLAR SYSTEMS

The ability to provide continuity of power is an important objective in the design of Remote Area Power Systems (RAPS). This is not easy when relying on natural elements which are variable and at times fickle. Wind power is subject to calm spells which, even in a windy area, may last several weeks, while reasonably cost effective storage batteries provide only 4-5 days supply at low consumption. Similarly solar power is subject to low output for considerable periods, particularly in winter.

A GOOD PAIR

Wind and solar energy inherently go together. It is the warming of the earths surface by the sun that creates the wind in the first place. A combination of wind and solar energy is effective in providing the sought after continuity of power supply in RAPS applications.

FILLING IN THE GAPS

In a hybrid Wind/Solar system, the large gaps in supply from a given source are offset by output from the other source. Reliance is spread between the two elements. In particular, wind systems have a high output producing large amounts of power but suffer from long gaps, while solar output, though more costly per peak watt than wind, has more even production which tends to be higher in calm weather.

The overall supply of a hybrid system relates nicely to the variable nature of demand, allowing for high peak use, but maintaining reliability for lower continual use. For example, in a domestic situation, uses tend to be spread between intermittent heavy ones - such as domestic appliances, vacuum cleaners and power tools - and continuous lighter uses - such as lighting, refrigeration, television, and stereo. Large power inputs from wind can be drawn upon for heavy loads while the smaller more even solar production improves supply for the lighter loads.

QUESTIONS

To what extent does the availability of power actually improve with a hybrid system? What are the economics of a wind/solar hybrid system?

ANSWERS FROM THE UNIVERSITY OF AUCKLAND

These questions have been discussed in a study carried out by C.C. King, University of Auckland in 1984/85.

A Soma 300 watt wind generator, a solar tracking device incorporating two Solar Wind 24 watt panels, and Lucas 12 Volt, 80 Ampere-hour deep hour cycle batteries were used. Various combinations of solar input and battery size were evaluated.

A detailed computer simulation was undertaken to test the cost efficiency of the system. Hourly records of sunlight and windspeed/direction were obtained from the Auckland Meterological office, covering the entire year from April 1984 to March 1985. These were then processed to simulate the actual site of the system (a more exposed site with a hill obstructing the south).

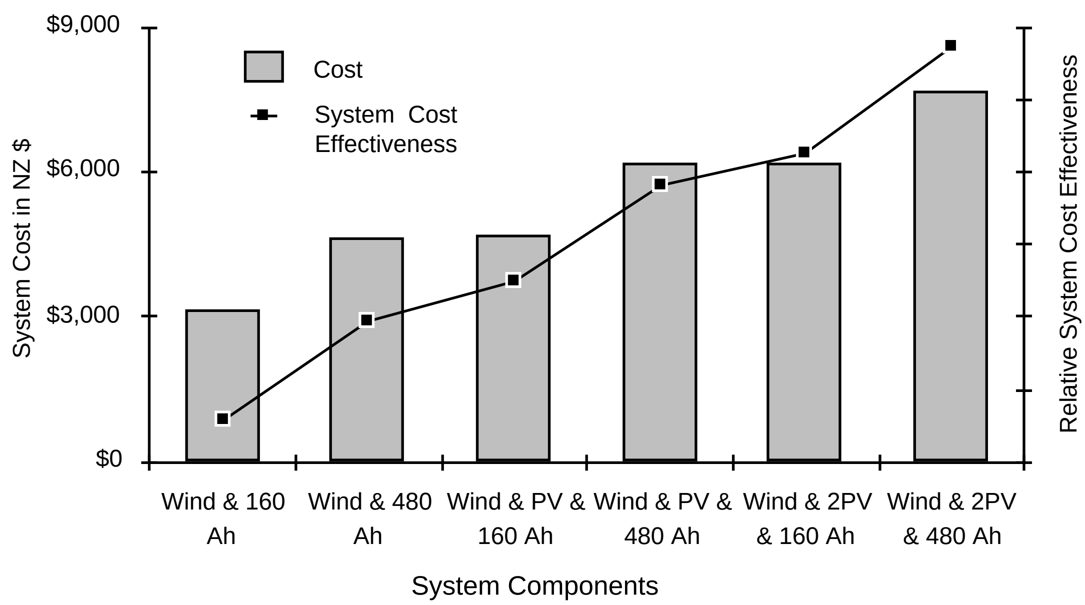
A further simulation was made of charging characteristics of various sizes of battery banks under various combinations of wind and solar output (wind alone, wind and 1 or 2 solar tracking devices). These simulations were made at different continuous demand levels. The combined solar/wind system had only one complete charge-discharge cycle while wind alone had nine. Since battery replacement is a significant maintenance cost factor, reduced battery wear is an important advantage.

An estimate was made of the days lost in the year for four systems (wind and wind/solar were tested with both 160 and 480 amp hours storage). The wind/solar system out performed the system using larger battery storage alone.

A cost effectiveness study was then undertaken by taking the costs of components and dividing them by the maximum sustained drain without loss of days. The sustained drain was measured both over the whole year and over periods of higher output.

Component costs, system performance and cost effectiveness are shown in the graph. These values indicate that a balanced wind/solar system with good storage actually doubles the cost-efficiency of production. Although the initial expense is higher, a hybrid system provides greater continuity of power supply at a lower cost per watt hour.

System Cost and Relative Performance



THE SOMA WIND GENERATOR

New Zealand's connection with California isn't one of size alone. For 12 years a native of Santa Barbara, CA has been building wind generators here in New Zealand.

Harold Ward sailed his 40 foot yacht across the Pacific to New Zealand in the years 1975-1977. Locals were soon to see the merits of the prototype wind generator he had built for his yacht and, one thing leading to another, "Wardy" began commercially building the machines in 1978. Soma Power Ltd. is now a well established company in Auckland manufacturing wind generators. The demand for wind generators through the early years was only just enough to keep one man in business, though it provided the experience to make the wind generator. As a result many 12 year old units are out there, testing the durability of the designs.

Development has been centered around the original alternator configuration of 12 or 24 poles of copper windings set around the central stationary aluminum stator housing. The appropriate number of ceramic ferrite magnets are set in an aluminum hub which rotates around the outside of the stator. Using this number of poles allows power output from the alternator at lower RPM than, say, a 4 pole automotive type alternator. As with all alternators there are no carbon brushes to wear out and replace. The alternator is directly driven by the 3 blades on the Soma windmill bolted to the face of the alternator hub. This is an extremely secure method of attachment with the hub having been designed to both take the blades and contain the magnets.

The Real Advantage

The real advantage of building the alternator from the ground up, in house, is that we can choose the materials for wind generator use and abuse. Corrosion resistant alloys are used for the stator and hub housings. The stator is completely encapsulated in high temperature epoxy resin. Copper windings can be varied in size to optimize output in relation to the blade characteristics and swept area. The blades and alternator are in effect "tuned" to go together.

Regulation

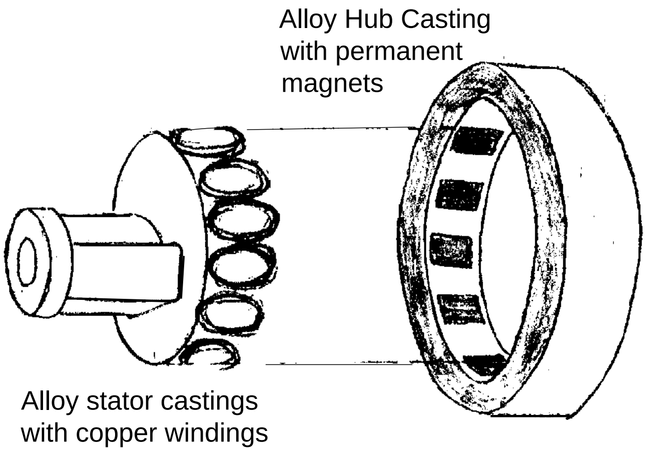
Regulation in high winds is now obtained by allowing the complete rotor to tilt upwards out of the wind reducing swept area presented to the wind. There is a gyration effect to consider with this type of regulation and the first prototypes would fly back or slam back down if a wind gust coincided with a change in wind direction. By placing a shock absorber on the tilt back mechanism the action is dampened and the windmill has a gentle tilting motion. Two weighted legs set at 45° to vertical enhance feathering through the first 45° of tilt and retard it through the reminder of the arc acting as counterbalance weights to bring the machine back to face the wind when the wind dies down.

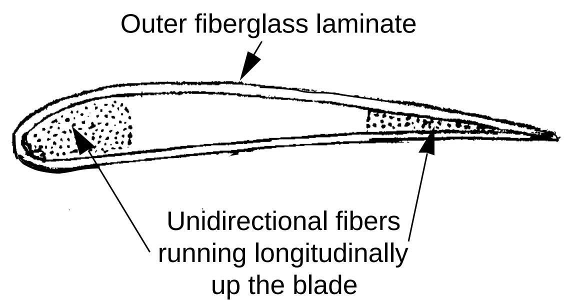
Blades

Soma windmills have always, since day one, had fiberglass blades. Although the exact laminations and concentrations of unidirectional fiber have changed, the process of manufacture remains the same. The blades are hollow molded with an outer fiberglass skin over a high proportion of unidirectional fibers running up the leading and trailing edges. Consistency in manufacturing for both shape and elasticity is an important advantage of fiberglass. The effect on performance of a blade that has warped is quite dramatic as is the effect of blades that twist or bend in a non-uniform manner while under load. Stainless steel tape protects the leading edge from long term erosion. The Soma 300 watt machine has 0.8 meter blades (1.7 meter diameter).

The alternator and blades are bolted to a galvanized steel swivel assembly which incorporates the tilt back mechanism and the tail vane. The swivel turns inside the top of a length of 3 inch galvanized pipe with "Ertalyte" self lubricating nylon bushings. This is a tough, low wearing material, especially effective for the low work rate experienced with windmill yaw.

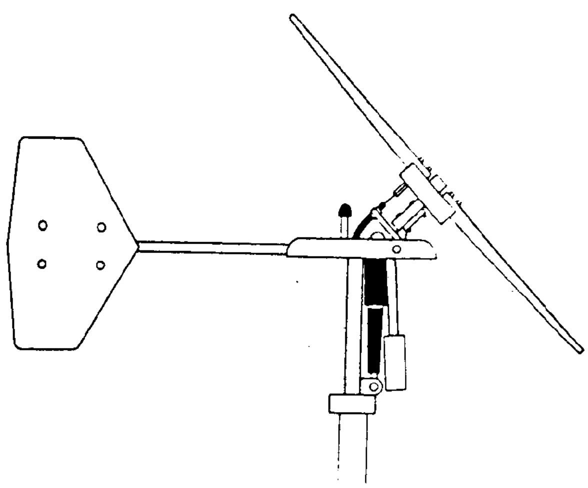
A view of the SOMA 300's alternator.

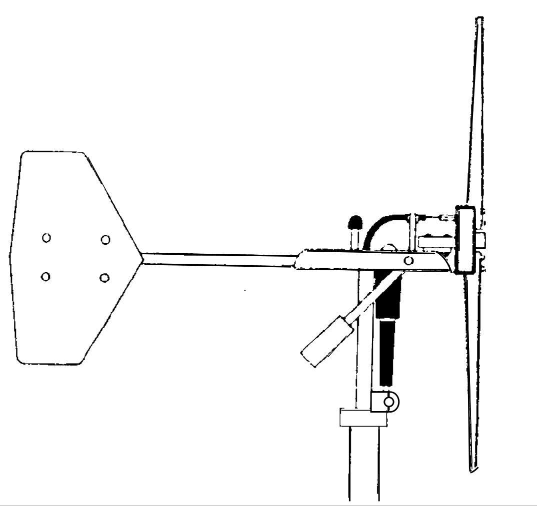




Earlier Days

In the earlier days the blades were feathered by way of centrifugal flyball type governor weights. It worked well and certainly looked very technological but was time consuming to produce and the number of parts involved added to the risk of mechanical failure. Now, by bolting the blades directly on to the face of the alternator hub, there is a robustness that is instinctively appealing.





TOWERS

The most common towers used with the Soma windmills are wooden telegraph poles. A 6 foot length of pipe is U-bolted to the 8 inch diameter top end of the pole. These towers are readily available in most places, are cheap, and provide the ideal medium for home built installations. Complete instructions for building this type of tower are included in the installation manual. Alternatively, 40 feet of the 3 inch galvanized pipe with guy wires makes a good tower.

SAFETY

Provision to shut the windmill down, and then to be able to restart it, from the ground, has been an important consideration for Soma. For safety reasons windmills must have a manual fail safe shut down mechanism (if you have ever seen a windmill out of control you'll know just how frightening it can be).

The approach on the Soma machine is for the electrical cable running between the alternator and the ground to double as a shut down pull chord. The mechanically strengthened cable can be pulled from the ground causing the windmill rotor to tilt completely back to horizontal. It is then held in the "off" position by a spring tensioning device at ground level. The machine is turned back on simply by releasing the chord.

ELECTRICALLY SPEAKING

The 12 or 24 volt 3 phase ac current is rectified in the control panel near the batteries. The amount of charge going in to the batteries is regulated by the voltage sensitive circuitry in the control panel. An amp meter gives a visual indication of the charge rate and when the batteries are fully charged the current is directed into a wire wound resistor dummy load which absorbs the excess power and keeps the wind generator fully loaded. Rated at the recognized standard windspeed of 10 ms or 23 mph the Soma F.P. 300 will deliver 300 watts while charging begins at 8 mph and peak output is 320 watts at 30 mph. The comprehensive installation and maintenance manual provides all of the information necessary for easy installation by the user. A job that will take two people 2 days to complete including building the tower.

One might say that Soma Power Ltd. has taken the "tractor" approach rather than the "sports car" approach in its design philosophy. The Soma F.P. 300 weighs in at 60 kg. and carries a one year warranty. This rugged toughness and durability has enabled the machine to survive whatever New Zealand winds can throw at it. One thing is for sure, it won't blow away in the wind.

ACCESS

David MacKay, SOMA Power Ltd., 1/28 Parkway Drive, Mairangi Bay, Auckland, New Zealand. Telephone: (9) 479 1605 or FAX (9) 478 7197.

THE SHOCKING STORY OF GROUNDING

John Wiles

The subject of grounding is one of the more confusing issues in the installation of PV systems. Even the word grounding has different meanings for different people. The National Electric Code® (NEC®) has specific definitions and requirements in this area--requirements that must be followed in order to have a relatively safe PV system. There are also some recommendations on grounding that should be followed to enhance system performance.

Definitions

The word GROUNDED means connected to the earth. The GROUNDED CONDUCTOR is a system conductor that normally carries current and is intentionally grounded. In PV systems, the NEC requires one conductor (normally the negative except for telephone systems) of a two conductor PV system, with an array open circuit voltage over 50 volts, to be grounded. Any PV system with three conductors--positive, negative, and neutral or array center tap--must have the neutral/center tap grounded. The GROUNDING CONDUCTOR is 1) a conductor that does not normally carry current and is used to connect all exposed, noncurrent-carrying metal surfaces of PV equipment to earth--also known as the Equipment Grounding Conductor or 2) a conductor that does not normally carry current and is used to connect the grounded conductor to the grounding electrode (rod) or grounding electrode system--also known as the Grounding Electrode Conductor.

The Requirements

All PV systems must have an equipment grounding system whether or not one of the current-carrying conductors is grounded. Grounding all exposed metal surfaces creates a barrier between the live conductors and the user. Since all surfaces are connected together and to earth, the voltage between them and earth even when a fault occurs, remains near zero. This minimizes the shock potential and is a requirement for any PV system. In a system with the proper overcurrent devices, the equipment grounding system also provides a mechanism to trip or blow over-current devices when a ground fault occurs. If this provision were not present, a faulty PV module or appliance, for instance, might have the frame or case connected to the positive conductor. The fault would not be noticed until a second fault occurred or the first came into contact with a water pipe or sink or, worse yet, someone made skin contact with a grounded surface and the faulty appliance.

Twelve and twenty four volt PV systems have open circuit voltages less than 50 volts and therefore are not required to have one conductor grounded. They must, however, have exterior metal surfaces of equipment grounded to comply with the NEC. This means three wire cables and three wire plugs and sockets for plug-in appliances so that the equipment grounding conductor connection can be made. Sorry, cigar lighter plugs and sockets do not qualify.

Any system with an open circuit voltage greater than 50 (i.e. 36, 48 and above systems) must have one conductor grounded in addition to the equipment grounding system.

Because DC fluorescent lights and inverters make less radio frequency noise when grounded and the lights seem to start a little easier, it is suggested that even 12 and 24 volt systems have one current carrying conductor grounded. This should provide extra protection in the event electromagnetic and electrostatic surges get into the system, since the grounded conductor stabilizes the system voltage with respect to ground and bleeds off such surges. Also, if you are using short wave radio equipment or other radio systems requiring outside antennas, they may already be grounding your PV system in a manner that does not provide the safest system.

Color Codes

Red is positive and black is negative and it always has been--right? WRONG! Ever since the beginning of time (1900 or so) the only color codes that have been approved for residential and commercial power wiring -no matter whether it is ac or DC are the following: The grounded conductor, if any, shall be white or a natural gray rubber color. The equipment grounding conductor shall be bare, green, or green with a yellow stripe. No other colors are specified, but power wiring has for years been: Black is the hot (nongrounded) conductor, white is the grounded neutral conductor, and bare or green is the grounding conductor. In 240/120 volt ac systems, the additional hot conductor is usually red but this color is not required by the code. In industrial dc systems, the center tap or neutral which is grounded is white and here at last the positive cable may be marked red and the negative cable marked black. The local inspector will be looking for that green or bare grounding conductor in all PV systems and a white grounded conductor in those over 50 volts or those which are grounded below 50 volts.

Equipment Grounding

The size of the green or bare equipment grounding wire must be at least as big as the current carrying conductors between the two pieces of equipment being connected. It can have a current-carrying capacity (ampacity) no less than the ampacity of the overcurrent device protecting the circuit. This is easy to do if 10-2 (American Wire Gauge-AWG) with ground, or 12-2 AWG with ground nonmetallic cable is used and the fuses or circuit breakers are rated at 30 amps (10-2 cable) or 20 amps (12-2 cable). If you have a metallic battery box to ground or an inverter chassis and have used 4/0 AWG conductors between the battery and the inverter, then the grounding conductor must be as large as the current-carrying conductors - in this case 4/0.

The equipment grounding conductors must at some point be connected directly to the grounding electrode which must be a 5/8" metal rod driven at least 8 feet into the earth. This grounding electrode conductor should be the same size as the largest equipment grounding conductor in the system even if this is 4/0 AWG between the battery and the inverter as used in the example.

The frames of the PV arrays must be connected to the equipment grounding system with a green insulated or bare conductor. For additional protection against lightning strikes, it is suggested that a separate ground rod be used as near the array frames as possible and a large (at least number 6 AWG) conductor be connected between the frames and the grounding rod with no splices and a minimum number of bends.

System Grounding

For grounded systems, the grounded conductor must also be connected to the grounding rod. Again, the grounding electrode conductor must be as large as the largest current-carrying conductor in the system. This conductor should be attached to the end of the largest negative conductor nearest the PV array. In most cases this will be either the negative battery terminal or the negative inverter terminal. There must be only one connection between the negative current-carrying conductor and the grounding electrode. Failure to adhere to this requirement will result in hazardous currents flowing in the grounding conductor. Furthermore, there can be no splices in the grounding electrode conductor.

All grounding rods in the system must be bonded (connected) together with conductors equal to the size of the largest grounding electrode conductor. Because of the high cost of large cable, it is suggested that with careful planning, the ac and DC ground rods can be one and the same and for roof mounted arrays, this might also be the same rod used to ground the array frame.

Now that we are connected, the next step is to be able to disconnect--the subject of the next Code Corner.

Access

John Wiles, SouthWest Technology Developemnt Institute, Las Cruces, NM.

Things that Work! The Select-A-Tenna

testing conducted by Sam Coleman

The Select-A-Tenna is an effective, compact AM radio antenna that uses no electricity and has no wiring to hook up. I was skeptical when I unpacked it. Could it possibly work? It had no batteries, no power cord, and maybe most mystifying of all, no wires to hook it up to my radio. The Select-A-Tenna is a working device and I'm indeed amazed.

Physical Dimensions and Docs
The Select-A-Tenna is 10.75 inches in diameter and 2.25 inches thick. It weighs 2 pounds. The exterior case is made from brown ABS plastic and has a large tuning knob in its center. It was well packaged and arrived in fine shape via UPS. Documentation was good and I immediately went to work testing the antenna in my system.

The Selecta-A-Tenna.
Photo by Richard Perez

Test System
The radio receiver used to test the Select-A-Tenna was a Sony multiband type, model ICF-6700W with built-in ferrite AM antenna. This radio is powered by the 12 Volt PV/battery system via a home made 9 VDC power supply. All measurements are directly taken from the signal strength meter on the Sony. Testing was conducted at Agate Flat, Oregon (42° 01'N. 122° 22'W.) at an altitude of 3,320 feet. With the exception of a chronically noisy 60 kiloVolt commercial power line nearby, this site is generally RF quiet.

Using the Select-A-Tenna
The thing is so simple to use that its a shame to have to talk about it. Just put the Select-A-Tenna within six inches of the radio's back or side, whichever place works best. That's it, no wiring!

Since the Select-A-Tenna is a loop type antenna it is directional. By rotating the antenna and the radio's position in space, interfering signals can be reduced or even eliminated. Rotation of the radio/antenna system also increases the incoming signal strength.

Test Results
The table and graph on the next page show my test results. The table contains three sets of data taken at three different times of day. The distance in miles between my receiving station and the AM radio station's transmitter were figured on longitude and latitude via the great circle route. This distance therefore represents the radio wave's shortest possible path. Improvement on the table was calculated as a percentage increase of the signal strength without the Select-A-Tenna.

The Select-A-Tenna seems to work best on stations over 60 miles distant. Here signal strengths increase up to 525%. During the 11 AM test the Select-A-Tenna increased signal strengths an average of 228%. During the 5 PM test the Select-A-Tenna increased signal strengths an average of 170%. During the 10:30 PM test the Select-A-Tenna increased signal strengths an average of 45%.

The Select-A-Tenna pulled out signals from the noise that were not even there without the antenna. It is also effective in reducing noise on audible signals, even strong ones. And the Select-A-Tenna allowed me to listen to to different AM stations on the same frequency without having them interfere with each other.

A very interesting feature of the Select-A-Tenna is that you can rotate it to beam in signals from a particular direction. This is impossible with long wire antennas.

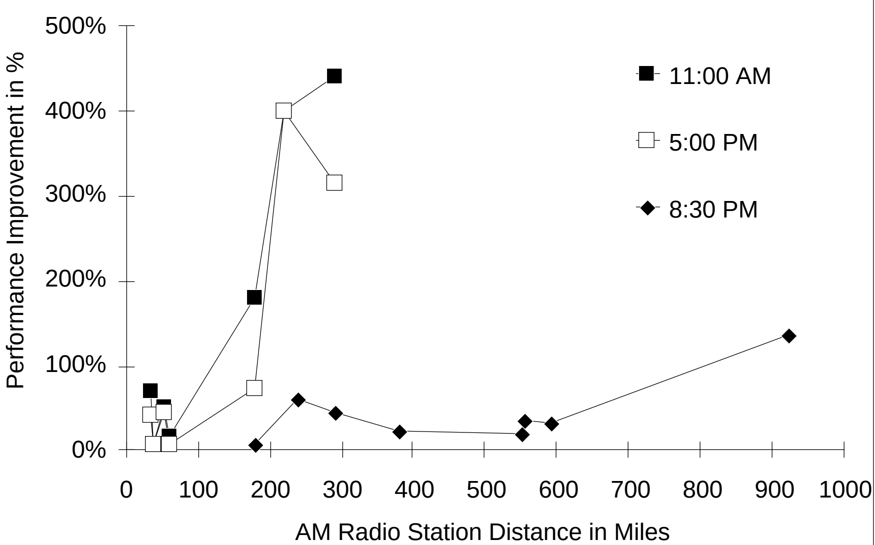
How the Select-A-Tenna Works
The Select-A-Tenna is a resonant loop antenna that is tuned with a variable capacitor. Orienting the loop so that the axis of its toroid is perpendicular to the incoming radio waves causes the loop antenna to focus the radio waves on the receiver's built-in ferrite antenna. According to the C. Crane Company, who makes the Select-A-Tenna, it produces a net gain of +30 decibels.

Conclusions
The Select-A-Tenna not only works well, but is amazing because it uses NO electricity or direct connection to the radio receiver. It is a good value at $46.95. Since it contains no transistors or active components, it should last a very long time. Since it lives inside, next to the radio, instead of outside in the weather, the Select-A-Tenna may last forever. I recommend it to any AM radio junkie.

Access
The Select-A-Tenna is manufactured by the C. Crane Company, 147 Watson Lane, Fortuna, CA 95540 • 707-725-5940

Select-A-Tenna Performance
at Agate Flat, OR (42°01'N. 122°22'W.)

AM Freq. in kHz.	Time of Day	Plain Radio	Radio with Select-A-Tenna	Improvement	Miles to Station	Station Location
1530	11:00	1.25	3.50	180%	180	Sacramento, CA
1230	11:00	4.25	7.25	71%	35	Talent, OR
1150	11:00	4.00	6.00	50%	55	Klamath Falls, OR
810	11:00	0.05	0.25	400%	290	San Francisco, CA
780	11:00	0.05	0.25	400%	220	Reno, NV
730	11:00	6.00	6.50	8%	40	Medford, OR
680	11:00	0.05	0.25	400%	290	San Francisco, CA
620	11:00	3.00	3.50	17%	60	Mt. Shasta, CA
560	11:00	0.08	0.50	525%	290	San Francisco, CA
1530	17:00	2.00	3.50	75%	180	Sacramento, CA
1230	17:00	5.25	7.50	43%	35	Talent, OR
1150	17:00	5.00	7.25	45%	55	Klamath Falls, OR
810	17:00	0.05	0.25	400%	290	San Francisco, CA
780	17:00	0.02	0.10	400%	220	Reno, NV
730	17:00	6.00	6.50	8%	40	Medford, OR
680	17:00	0.20	0.50	150%	290	San Francisco, CA
620	17:00	2.75	3.00	9%	60	Mt. Shasta, CA
560	17:00	0.05	0.25	400%	290	San Francisco, CA
1530	20:30	7.50	8.00	7%	180	Sacramento, CA
1190	20:30	3.25	5.25	62%	240	Portland, OR
1160	20:30	4.80	6.50	35%	555	Salt Lake City, UT
1000	20:30	5.50	6.80	24%	380	Seattle, WA
850	20:30	0.80	1.90	138%	920	Denver, CO
810	20:30	6.25	7.10	14%	290	San Francisco, CA
720	20:30	5.00	6.00	20%	550	Las Vegas, NV
680	20:30	4.90	6.00	22%	290	San Francisco, CA
640	20:30	3.00	4.00	33%	590	Los Angeles, CA
560	20:30	2.00	4.00	100%	290	San Francisco, CA



A Note about "Things that Work!"

I've been taking some flak lately about putting advertisments for products adjacent to their "Things that Work!" article. Time has come to get something straight.

"Things that Work!" articles cannot be bought and do not depend in any way on advertising.

We write up these products because they do indeed work, last, and are worth their cost. These are the only criteria.

We've lost thousands of dollars in advertising because we have refused to write up junk. In one particular case, the advertiser pulled an entire page ad, scheduled months in advance, because we would not pass his product as a "Things that Work!".

I put the ad with the article whenever possible because it makes it easier for you to find the product. That's all there is to it…

Specifying PV Wiring

Richard Perez

Questions flood into HP Central via mail and phone. High on the hit parade is, "What size wire do I need to hook-up my PV array?" Well, here's the straight info on specifying wire gauge between the photovoltaics and the controller/battery. Electricity produced by photovoltaics is low voltage. Low power loss in low voltage wiring is essential for effective performance.

A Short History

I feel that the subject of wiring and interconnection is so important and so misunderstood, that we have run many articles about this subject. Here's a list: HP2-pg 11, HP2-pg 33, HP3-pg 40, HP4-pg 33, HP6-pg 35, HP7- pg.36. Wiring articles after HP11 are listed under Basic Electric in the index in this issue, see page 49.

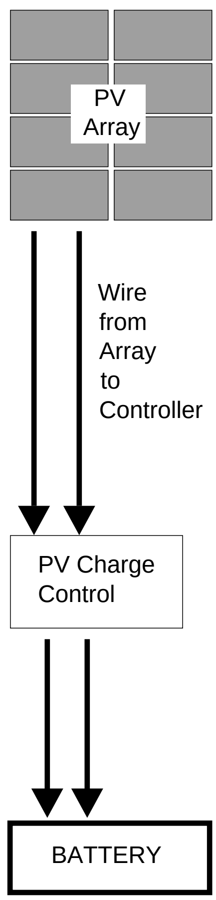
This article doesn't probe the depths of Ohm's Law and the Copper Wire Table. Here the work is done for you. You have only to look up your situation on the tables. You must, however, use the tables properly if you are to get real answers instead of bogus info.

Wiring on the PV Array

A photovoltaic array consists of several PV panels wired in parallel (12 Volt systems) or in series/parallel (24 Volt systems). The interconnects between the individual modules can be made with 10 gauge copper wire. Use stranded, copper wire with a "USE" or "UF" insulation because these outer coatings will resist sunlight degradation. Use of 10 gauge is practical because the current from an individual module is low (≈3 Amps.) and the distances are short (usually <2 feet). These wires connect to the better-quality PV panels with ring connectors. Solder these ring connectors to the wire! If you are using panels that don't take ring connectors, then tin the wire ends with solder before installation. See page 35 of this issue for soldering info.

Wiring between the PV Array and the Controller

This is really what we are interested in here. The distance between the array and the control is often many feet, and is different for each system. Since the PV controller is usually located very near the batteries, the distance here is not a problem. This is not the case with the array to controller circuit. Often we have to mount the PV array some distance from the battery in order to get the array into a better, more sunny, location. The illustration to right shows the PV array to Controller wiring circuit covered here.



The Tables

On the next page, there are two wiring tables. Both tables are for copper wire only. The upper table is for 12 Volt systems and the lower for 24 Volt systems. The upper horizontal row of each table contains the PV array current in Amperes. The left most, vertical column contains the round trip wire length in feet. Now, this is ROUND TRIP! If the array is 100 feet from the controller, then 200 feet of wire is required (two conductors).

The information on these tables was computed on the following criteria. The wiring efficiency must be 97.5% efficient. Efficiency was computed as power through the circuit minus the power lost to the voltage drop in the wiring . The wire is also specified by ampacity. Ampacity is the current handling capability of a conductor regardless of its length. Ampacity is directly proportional to the cross-sectional area (diameter) of the wire.

Using the Tables

Use the upper table for 12 Volts and the lower table for 24 Volts. Locate your array's current on the upper row. Now locate your round trip wiring length in feet on the left most, vertical column. The correct wire gauge number is located at the intersection of the row and column you have chosen. The wire gauge number is American Wire Gauge (AWG). Please note that the computer designates "00" gauge as -1,"000" gauge as -2,"0000" gauge as -3.

If you want even higher wiring efficiency, then use the next larger wire gauge. If you live in an area that is hot (average daytime temperature >90°F. for at least six months yearly) then use the next larger wire size. Remember, as the wire diameter gets larger the AWG number gets smaller. Since you may want to add more PV panels to your array in the future, specify the wire for the biggest array you think you will ever use. Wire doesn't wear out, so if you buy wire that is large enough, you will never have to replace it.

I bought the BIG Wire, so I'm in, right?

Not quite. Even the largest wire can be rendered completely ineffective by poor electrical connections to the wire. A series electrical circuit is like a chain- only as strong as its weakest link. Each and every element in a series circuit must be low loss in order for the entire circuit to be low loss. It only takes one funky connection to shoot down the whole circuit. Solder all low voltage connections wherever possible. The article on page 35 of this issue gives you all the soldering info you need to make your investment in large wire permanent.

Access

I have the original, working spreadsheets that generated these tables. These spreadsheets are in Excel 2.2 for the Macintosh computer. If you want a copy of the spreadsheets, send me a 3.5 inch diskette in a mailer with return postage included. Richard Perez, C/O Home Power Magazine, POB 130, Hornbrook, CA 96044.

PV ARRAY CURRENT IN AMPERES.

		6	12	15	18	21	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
R	25	13	10	10	9	8	7	6	6	5	4	4	4	3	3	2	2	2	1	1	0	0	0
O	30	13	10	9	8	7	7	6	5	4	4	3	3	2	2	2	1	1	1	0	0	0	0
U	35	12	9	8	7	7	6	5	4	4	3	3	2	2	1	1	1	0	0	0	0	-1	-1
N	40	11	8	7	7	6	5	4	4	3	2	2	1	1	1	0	0	0	-1	-1	-1	-1	-1
D	45	11	8	7	6	6	5	4	3	3	2	1	1	1	0	0	0	-1	-1	-1	-2	-2	-2
	50	10	7	7	6	5	4	4	3	2	1	1	1	0	0	-1	-1	-1	-1	-2	-2	-2	-2
T	60	10	7	6	5	4	4	3	2	1	1	0	0	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3
R	70	9	6	5	4	4	3	2	1	1	0	0	-1	-1	-2	-2	-2	-3	-3	-3	-3		
I	80	8	5	4	4	3	2	1	1	0	-1	-1	-1	-2	-2	-3	-3	-3					
P	90	8	5	4	3	3	2	1	0	0	-1	-2	-2	-2	-3	-3	-3						
	100	7	4	4	3	2	1	1	0	-1	-1	-2	-2	-3	-3								
W	125	7	4	3	2	1	1	0	-1	-2	-2	-3	-3										
I	150	6	3	2	1	0	0	-1	-2	-3	-3												
R	175	5	2	1	0	0	-1	-2	-3	-3													
E	200	4	1	1	0	-1	-1	-2	-3														
	225	4	1	0	-1	-1	-2	-3															
L	250	4	1	0	-1	-2	-2	-3															
E	275	3	0	-1	-2	-2	-3																
N	300	3	0	-1	-2	-3	-3																
G	325	2	-1	-2	-2	-3																	
T	350	2	-1	-2	-3	-3																	
H	375	2	-1	-2	-3																		
	400	1	-1	-2	-3																		
in	425	1	-2	-3																			
	450	1	-2	-3																			
F	475	1	-2	-3																			
E	500	1	-2	-3																			
E	600	0	-3																				
T	700	-1																					

12 VDC

Specification Voltage 15 VDC
for 12 VDC PV Applications

Wiring is specified for a power efficiency of 97.5%
and/or correct ampacity

Codes

The body of the table contains the Wire Gauge Number
"0" Wire is designated by 0
"00" Wire is designated by -1
"000" Wire is designated by -2
"0000" Wire is designated by -3

Wiring power efficiency is specified at 68°F.
If ambient temperature is > 90°F., use the next gauge larger wire

PV ARRAY CURRENT IN AMPERES.

		6	12	15	18	21	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
R	25	14	13	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
O	30	14	13	12	11	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
U	35	14	12	11	10	10	8	6	6	6	6	6	5	4	4	4	2	2	2	2	0	0	0
N	40	14	11	10	10	9	8	6	6	6	5	5	4	4	4	3	2	2	2	2	0	0	0
D	45	14	11	10	9	9	8	6	6	6	5	4	4	4	3	3	2	2	2	2	0	0	0
	50	13	10	10	9	8	7	6	6	5	4	4	4	3	3	2	2	2	1	1	0	0	0
T	60	13	10	9	8	7	7	6	5	4	4	3	3	2	2	2	1	1	1	0	0	0	0
R	70	12	9	8	7	7	6	5	4	4	3	3	2	2	1	1	1	0	0	0	0	-1	-1
I	80	11	8	7	7	6	5	4	4	3	2	2	1	1	1	0	0	0	-1	-1	-1	-1	-1
P	90	11	8	7	6	6	5	4	3	3	2	1	1	1	0	0	0	-1	-1	-1	-2	-2	-2
	100	10	7	7	6	5	4	4	3	2	1	1	1	0	0	-1	-1	-1	-1	-2	-2	-2	-2
W	125	10	7	6	5	4	4	3	2	1	1	0	0	-1	-1	-2	-2	-2	-2	-3	-3	-3	-3
I	150	9	6	5	4	3	3	2	1	0	0	-1	-1	-2	-2	-2	-3	-3	-3				
R	175	8	5	4	3	3	2	1	0	0	-1	-1	-2	-2	-3	-3	-3						
E	200	7	4	4	3	2	1	1	0	-1	-1	-2	-2	-3	-3								
	225	7	4	3	2	2	1	0	-1	-1	-2	-3	-3	-3									
L	250	7	4	3	2	1	1	0	-1	-2	-2	-3	-3										
E	275	6	3	2	1	1	0	-1	-2	-2	-3	-3											
N	300	6	3	2	1	0	0	-1	-2	-3	-3												
G	325	5	2	1	1	0	-1	-2	-2	-3													
T	350	5	2	1	0	0	-1	-2	-3	-3													
H	375	5	2	1	0	-1	-1	-2	-3														
	400	4	1	1	0	-1	-1	-2	-3														
in	425	4	1	0	-1	-1	-2	-3															
	450	4	1	0	-1	-1	-2	-3															
F	475	4	1	0	-1	-2	-2	-3															
E	500	4	1	0	-1	-2	-2	-3															
E	600	3	0	-1	-2	-3	-3																
T	700	2	-1	-2	-3	-3																	
	800	1	-1	-2	-3																		

24 VDC

Specification Voltage 30 VDC
for 24 VDC PV Applications

Wiring is specified for a power efficiency of 97.5%
and/or correct ampacity

Codes

The body of the table contains the Wire Gauge Number
"0" Wire is designated by 0
"00" Wire is designated by -1
"000" Wire is designated by -2
"0000" Wire is designated by -3

Wiring power efficiency is specified at 68°F.
If ambient temperature is > 90°F., use the next gauge larger wire

Subscription Form

Home Power Magazine

$6 per year (6 issues) to US Zip Codes via 3rd Class
$20 per year (6 issues) to US Zip Codes via 1st Class

If you want to subscribe to Home Power Magazine, please fill out the subscription form below, write a check or money order, & drop it in the mail. Tape the form well or use an envelope so your check doesn't fall out in the mail. **Please note:** 3rd Class mail is not forwardable. We are not responsible for undelivered 3rd class issues. If you move you must send us your new address or your copies will not get to you. We encourage you to use this form to communicate with us.

For those wishing **Back Issues of Home Power for $2 each, or international subscriptions**, please see **page 63**.

- ☐ New 1st ClassSub-$20 to USA Zip Codes
- ☐ New 3rd ClassSub-$6 to USA Zip Codes
- ☐ Change of Address **Include old Address**
- ☐ New Info on your System

PLEASE PRINT CLEARLY. GIVE YOUR C O M P L E T E ADDRESS.

NAME ______________________________

STREET ______________________________

CITY ____________ **STATE** ________ **ZIP** ________

The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a subscription, but we would greatly appreciate this information so we may better serve you.

FOR OUR PURPOSES WE DEFINE ALTERNATIVE ENERGY AS ANY ELECTRICAL POWER NOT PRODUCED BY OR PURCHASED FROM A COMMERCIAL ELECTRIC UTILITY.

I NOW use alternative energy (check one that best applies to your situation).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs)**

I want to use alternative energy in the FUTURE (check one that best applies).

- ☐ **As my only power source**
- ☐ **As my primary power source**
- ☐ **As my backup power source**
- ☐ **As a recreational power source (RVs)**

My site has the following alternative energy potentials (check all that apply).

- ☐ **Photovoltaic power**
- ☐ **Water power**
- ☐ **Wind Power**
- ☐ **Other** ____________

HP#18

I now use OR plan to use the following alternative energy equipment (check all that apply).

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
☐	☐	**Battery Charger**	☐	☐	**Control systems**
☐	☐	**Instrumentation**	☐	☐	**PV Tracker**

FOLD HERE

& TAPE

Please write to us here. Tell us what you liked and didn't like about Home Power. Tell us what you would like to read about in future issues. Thanks for your time, attention & support.

☐ Check here if it's OK to print your comments as a letter to Home Power.

FOLD HERE

Return Address

____

____

____

Place
25¢
Stamp
Here

HOME POWER MAGAZINE
POST OFFICE BOX 130
HORNBROOK, CA 96044-0130

How to Solder- the basics

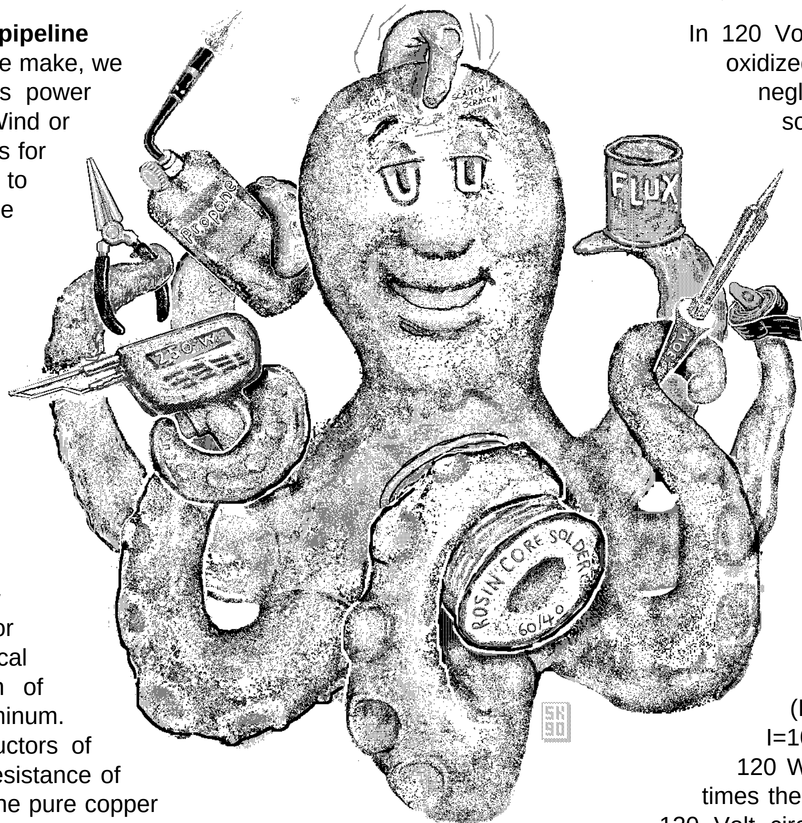
Richard Perez

Soldering insures permanent, low loss, electrical connections. A soldered electrical connection is not difficult to make, it only requires a little practice and the right tools. If you're making your own power, then your system's wiring and its maintenance are critical. Without good electrical connections, even the finest system will perform poorly or not at all. Here's what you need to know to make effective soldered connections for your system.

Interconnection- the electric pipeline

In order to use the electricity we make, we need wiring. Wiring transfers power from its source (PVs, Hydro, Wind or what have you), to the batteries for storage, and from the batteries to the appliances which consume the power. The chain of wires and connections that eventually leads to say turning on a light, must remain intact if the light is to operate. It only takes one weak or bad link in this chain to render the entire circuit inoperative.

Electrical wiring is made of copper and aluminum because both metals have low resistance to electron flow (electric current). The major problem with mechanical connections is the formation of oxides on the copper or aluminum. These oxides are poor conductors of electricity and increases the resistance of the mechanical connection. The pure copper or aluminum on the surface of the wire gradually changes to copper oxide or aluminum oxide by chemical reaction with the oxygen in the air and in the water. I shudder to think of what acid rain does…



Why Solder?

Mechanical connections are made by twisting the bare wires together or by compressing a wire into a connector or terminal. Wire nuts make mechanical connections that, while better than twisted wire connections, still don't prevent oxidation within the electrical connection. As the wires that make up the mechanical connection oxidize, the electrical resistance of the connection increases. This results in a voltage loss across the connection. This voltage loss is directly proportional to the amount of current flowing. The loss of voltage (and thereby power) across the connection manifests itself as heat- the oxidized mechanical connection gets hot. On the other hand, a well made soldered connection will have about half the resistance of a new mechanical connection and will not oxidize with time. Years down the road, the soldered connection will have many times less resistance than the oxidized mechanical connection.

In 120 Volt wiring, the voltage loss due to oxidized mechanical connections is negligible because the input voltage is so high- 120 vac and thereby the current flow is low. Here, mechanical connections are standard and perfectly acceptable. In 12 Volt systems, however, the voltage loss is appreciable. For example, consider a 120 Watt load being powered via a mechanical connection with a resistance of 0.2 Ω (a fairly typical funky connection's resistance). At 120 vac, the 120 Watt load will consume 1.0 Amperes of current (I=P/E, I=120 Watts / 120 Volts, I=1.0 Amperes). At 12 VDC, the 120 Watt load will consume 10 Amperes of current (I=P/E, I=120 Watts / 12 Volts, I=10.0 Amperes). In order to transfer 120 Watts of power, we must move ten times the current in a 12 Volt circuit as in a 120 Volt circuit. Increased current produces increased voltage loss across a bad connection. The voltage losses and power losses for this scenario are in the spreadsheet below (calculated at a variety of voltages and using Ohm's Law).

Power	120	Watts
Resistance	0.2	Ohms (Ω)

	Current Amps.	Voltage Loss	Voltage Loss %	Voltage Thru	Power Loss Watts	Power Loss %
12 Volts	10.0	2.0	16.7%	10.0	20.0	16.7%
24 Volts	5.0	1.0	4.2%	23.0	5.0	4.2%
36 Volts	3.3	0.7	1.9%	35.3	2.2	1.9%
48 Volts	2.5	0.5	1.0%	47.5	1.3	1.0%
120 Volts	1.0	0.2	0.2%	119.8	0.2	0.2%
240 Volts	0.5	0.1	0.0%	239.9	0.1	0.0%

Note that the voltage loss for the 120 Watt load is only 0.2 Volts at 120 Volts input. However the voltage loss for the same 120 Watt load at 12 Volts is 2 Volts. The 120 Volt system shows a percent loss of 0.2%, barely worth mentioning. The voltage loss in the 12 Volt system is large- 16.7 % of the initial input voltage. The net result of this scenario is that the 120 Watt load will barely function on the 10 Volts leftover after the bad connection gets its share of the power. Low loss, low resistance electrical connections are essential in systems using voltages under 30 Volts.

Soldering a connection insures that it will not oxidize and increase in electrical resistance. Do it right once, and it will work right forever. But you must do it right. A bad soldered connection can have more resistance than a mechanical connection.

When to Solder
Any low voltage electrical connection, involving copper wire, where oxidation or corrosion is a potential problem is a candidate for soldering. Obviously, there will be some mechanical connections in the system. It's not prudent or possible to solder to battery terminals, inverters, and controls- here mechanical connections are appropriate. Here are some appropriate places for solder.

• Any connection that lives outside in the weather, especially wire to ring connector connections.

• Low voltage wiring where it connects to the main DC buss.

• Any low voltage appliance's power wires where the appliance is stationary and thereby doesn't need a plug. For example, a ceiling light doesn't need a plug.

• Connectors on all battery or cell cables. The corrosive environment surrounding batteries will ruin mechanical connections very quickly. The connectors used to bolt to the cells must be soldered to their cables. See HP#7, page 36 for a detailed article on building these cables.

• Any place you want to save money. Not only is soldering more permanent than mechanical connections, but it's far less expensive. Connectors, wire nuts, crimpers and the like cost at every connection. Once the soldering equipment is paid for, the soldered joint is far less expensive as well as more durable.

What is Soldering?
Soldering is the process of bonding bits of copper together by flowing a molten mixture of tin and lead over the copper. The solders used will be detailed later, but they are mostly mixtures of tin and lead with a flux added. A flux is a chemical compound that, when hot, will chemically strip off the oxidized surface layer of copper and allow the solder to bond to clean, pure metal.

The Tools
The tools needed to solder are few: a source of heat (soldering iron), solder, and flux. The soldering iron should fit the job at hand. Just as you can't remove a 1 inch nut with a 1/2 inch wrench, you can't solder big cables with a small iron. Soldering irons are mostly electrically powered and come in sizes from 4 Watts to over 300 Watts and available with input voltages of either 12 and 120 Volts. Some are butane or propane powered. If you are serious about soldering, then you will need several sized irons, just like you need different sized wrenches or screwdrivers. After all, Rembrandt didn't use just one brush.

Low Wattage Irons
These little jewels are designed for use on electronic printed circuit boards/wiring or small sized house wires (up to 14 gauge). They put out between 4 and 25 Watts of heat to a tip that does the soldering. Pictured here is the Weller TCP-12 which consumes 2.3 Amperes at 12 VDC. The TCP-12 is thermostatically controlled to keep tip temperature in line (700°F.) and prevent the iron from burning up its tip when not in active use. The TCP-12 costs about $50. and is professional quality, we've used the one pictured for over eight years in heavy service. Tips come in all sizes and are easily replaced. Another iron pictured below is a PortalSol unit powered by butane. It is adjustable from about 4 to 75 Watts (see HP#16, page 39). A similar model is available from Radio Shack (RS# 64-2161 for $29.95).

Medium Wattage Irons
These irons are usually 120 vac operated and produce between 45 and 260 Watts. The large Weller soldering gun (Model D550) below is our favorite and runs on inverter produced power very well. It produces enough heat to quickly solder several 10 gauge copper wires. Soldering ring connectors and tinning wire up to 8 gauge is easily accomplished with the Weller gun. It has two heat levels- 200 and 260 Watts, but we run it wide open almost all the time. This soldering gun and others are available at hardware stores for under $40.

The Heavy Weights

For heavy duty soldering it's hard to beat a propane torch with soldering tip. These are universally available from hardware and discount stores for less than $30. See the article in HP#7, page 36 for detailed info on torch type soldering. Care must be taken in torch soldering not to burn the flux with the open flame.

What Kind of Solder to Use

The chemical composition of solder varies and its utility also varies with its content. The best type is made from $\geq$60% tin & $\leq$40% lead, with a built-in rosin (that's tree sap) core for flux. This type is becoming less common in favor of the 40% tin & 60% lead varieties. The types with less tin than lead are not only more difficult to use (poor wetting characteristics), but make a joint with less mechanical strength. Don't use a solder with a tin content less than 40%. Don't use solder with acid core flux, it is for plumbing. Rosin core fluxes are noncorrosive and should be used on all electrical work regardless of solder composition.

The Ritual of Solder

Soldering is a skill that has seven basic steps. If you follow these steps, you will get a permanent, good connection every time.

① Use a soldering iron sized to fit the job. Use low wattage irons for small connections with small thermal mass and high wattage irons for big jobs with large mass.

② Solder only clean copper. Soldering will not work on corroded, greasy or dirty copper. Sand or polish all the parts of the connection bright before soldering.

③ Make a tight mechanical connection before soldering. Soldering is not a substitute for mechanical connection, it merely makes it permanent by sealing out oxidation. Twist wires together firmly, or crimp wire into a connector before soldering.

④ Heat up the iron, clean (wipe with cloth or paper towel), and re-tin its tip with fresh solder just before making a solder joint. It is impossible to effectively transfer heat from a funky soldering iron tip.

Practice makes Perfect

Soldering is a skill. It takes practice. Work with scraps until you can get good joints. Underheat the work and see what happens. Overheat joints until you can see the effects of too much heat. These skills can be learned by anyone willing to pay attention for a single afternoon.

The Advantages?

Your work lasts. A soldered connection is good forever. Do it right once and future generations can use the connection and sing songs in your praise.

⑤ Place the hot iron on the work and melt a small amount of solder on the tip where it meets the work. This small puddle of molten solder between the tip and the work greatly increases thermal transfer.

⑥ Then place the solder against the work, NOT against the soldering iron's tip. This melts the solder on the work where its flux will deoxidize the copper. Melting the solder against the tip causes the flux to eat up the tip instead of the copper oxide on the work. This makes a poor soldered joint and wears out tips rapidly.

⑦ Flow only enough solder into the joint as it will easily accept.

Is it a good soldered connection?

If the connection is a good one, then the solder will be bright and shiny. All solder surfaces will be concave (valleys) indicating good wetting of the solder. This means that enough heat was used to make the joint and that all parts were hot enough to suck up a good, yet thin, coat of the solder. Connections made with too little heat will show convex (hills or blobs) solder surfaces indicating that the solder didn't get hot enough to flow easily. Solder joints made with too much heat have a grey, dull appearance.

HAPPENINGS

Backwoods Solar - Solar Electric Classes

Backwoods Solar Electric is repeating last year's one day workshops in solar electric home design and installation. Solar electric design for a home power system, cost estimation, characteristics of electricity at a level for beginners, cost cutting by conservation, solar modules and mounts, wind generators, batteries, inverters, wiring and fuses, charge controls, water pumping, refrigeration, and lighting, will be explained and demonstrated. We will install a simple but complete solar power system to learn of hardware and testing. Additional videos available to see.

To Sign Up: Please register by mail first so we can balance class. This year the classes will be limited to 10 or fewer PRE-REGISTERED people. Registration of $40 includes 9AM-5PM class, evening discussions if desired, full lunch and several snacks, a textbook (worth $16), and other literature. ($30 each for couples sharing the book.) Free overnight camping is available for travellers & nearby solar bed & breakfast. Saturday September 1, 1990. Contact Steve or Elizabeth at Backwoods Solar Electric, 8530 Rapid Lightning Creek Road, Sandpoint, ID 83864 • 208-263-4290.

Sorry to say that by the time we received this info 3 of the 4 classes had come and gone. Glad to say there's still time to get in on the 4th. These folks are good! KP

2nd Annual Clean Air Fair in Southern Oregon

In order to provide a way for everyone to work on the air pollution problems of southern Oregon in a positive manner, the Oregon Environmental Council (OEC), along with local city and county governments, shopping centers and a TV station, are co-sponsoring the Second Annual Clean Air Fair this September 15, 1990. The Fair explores the clean technologies of the past, present, and future and allows people to view lifestyle changes that clean up our environment as opportunities rather than hardships.

The search for alternatives and efficiencies is the key to this open-air event, but, in order to attract the general public, the energy will be focused toward fun. Good food and strolling musicians will abound. Children's activities and door prizes are prominently featured. On the day of the event, the local transit district will provide free rides through out the region, and the Oregon State Extension Service will lead numerous bicycle tours through town and country. High profile runs of other alternative means of transportation are welcome.

The hope is to send a message of cooperation to the concerned citizens of the area and the state. The Clean Air Fair will be held September 15th from 11:00AM to 5:00PM in Hawthorne Park in the center of Medford, OR. To receive additional information, write to OEC, POB 1498, Jacksonville, OR 97530, or pick up the phone and call the OEC at (503) 899-7426.

We are going to the Clean Air Fair with our PV pumped fountain and lots of HP's to pass out. See you there! KP

1991 Solar World Conference

August 17-24, 1991, Denver, Colorado, USA is the site of the 1991 SOLAR WORLD CONGRESS of the International Solar Energy Society. Contact: American Solar Energy Society, 2400 Central Ave. Ste B-1, Boulder, CO 80301 USA, 303-443-3130, FAX 303-443-3212

ISES Call For Papers

The International Solar Energy Society (ISES) with headquarters in Melbourne, Australia, is a worldwide organization that has been promoting applications of solar energy for 35 years. The American Solar Energy Society (ASES) is the United States Section of ISES.

For more information and a copy of the Call-for-Papers, contact the American Solar Energy Society, 2400 Central Ave Ste B-1, Boulder, CO 80301, 303-443-3130, FAX: 303-443-3212

Simple Solar Technologies

This Fall, The Aprovecho Institute in Cottage Grove, OR is holding courses in rural self-reliance. Here's the courses being offered:

Energy Savers: Solar Cookers, Hayboxes and Hot Water Heaters - 1 September: Learn to make your own simple solar technology to heat water and cook food using free energy. Taught by Mike Fahy and Michael Schubert, appropriate technologies and Aprovecho residents. $35 includes lunch, materials and your take-home haybox.

Autumn Organic Gardening and food Preservation, Sept. 15 &16; Bamboo Maintenance & Propagation Sept. 22; Felting Techniques Sept. 29; Root Cellaring for Food Storage Oct. 6 & 7; Constructing a Retained Heat Bread Oven, Oct.5 & 6; Retained Heat and Baking Techniques, Oct. 7.

For more information Contact: Aprovecho Institute, 80574 Hazelton RD., Cottage Grove, OR 97424, USA Phone (503) 942-9434

Darryl Murphy's solar car. This model can do 45 miles per hour, and wore a Tennessee license plate, having passed the state requirements for road worthiness. Photo by Albert Bates.

Alternate Energy Fair Held at the Farm

Michael Traugot

The first Alternate Energy Fair of the Summer of 1990, held at the Farm Community in Summertown, TN, is now history, but the ripples will continue to be felt for some time. Over 100 campers came from as far away as California and MIchigan to display their devices, give and attend workshops, and share information and good vibes. Others who could not attend sent information to be displayed. Attendees dined on the finest in vegetarian cuisine (itself an alternate energy form) from the Veggie-Deli, and enjoyed the woods and swimming hole at the Farm.

People brought a good sampling of different alternate energy devices, both high and low-tech. A solar pump circulated water; solar box cookers baked potatoes and cookies; a pair of parabolic reflectors focused light on Stirling engines, which moved back and forth as long as the sun shone; a ram pump set up at a nearby creek pumped water ten feet into the air; water heated up in a solar shower and a solar car, fresh from the American Tour de Sol, gave people rides up and down the road. A standard Ford tractor ran on ethanol, accompanied by an explanation of how the major oil companies are conspiring to keep ethanol mixes off the market.

There was a micro-hydro turbine, disassembled for inspection, and an on-demand water heater, which was sold before the Fair was over. Tours of two nearby solar homes were offered, and most attendees made it to one or both of the tours. Meanwhile, the Farm's passive solar school building, the largest single display, remained impressively cool inside despite 90° plus temperatures outside.

Participants universally reported that the networking was the best thing about the Fair (along with the food). One pioneer said that he had been making his own power for eleven years, and had met more people doing the same thing at this fair than he had in all the previous eleven years.

At least two participants plan to come out with prototypes this summer and start selling their products. Howard Kress of Rome, GA is working on a 300 watt parabolic concentrator/Stirling engine unit to take the place the place of photovoltaics in a home power system. Darryl Murphy of Sale Creek, TN plans to start building solar cars for people soon. The model he brought to the Fair can do 45 miles per hour, and wore a Tennessee license plate, having passed the state requirements for road worthiness. Both inventors were gassed (pardon the pun) to meet so many other good folks interested in the same things.

Possibly due to a late start on publicity, there was not a large participation by local Tennesseans. However, several key people did attend. The assistant Principal from the local public high school came, and asked if we could bring some of these new ideas and technologies to his science classrooms next fall. A reporter from from the newspaper in neighboring Lawrenceburg, TN gave us a feature story on the front page. A beginning has definitely been made in terms of educating the local area about the possibilities of renewable, non-polluting energy, which was one of the major objectives of the Fair.

Most of the participants enthusiastically declared that they would like to do it again next year. Before the Fair ended, participants held a meeting and formed a committee to stay in touch and plan next year's Fair. Financially, the Fair broke even, although it depended largely on volunteer time. With a little more planning and publicity and an earlier start, the Fair could be much bigger next year and have a greater impact in the local area.

ALTERNATE ENERGY DEMONSTRATION KIT

During the Alternate Energy Fair at the Farm in Summertown, TN, I was asked by the assistant principal of the local public high school if I could bring some of the ideas and technologies shown at the Fair into his science classrooms next year. I said I would be glad to. We also have a good connection with a science teacher in nearby Lawrenceburg, TN, and several public officials have expressed interest in seeing more, so it feels like an opening has been created for getting the word out about clean, renewable sources of power.

I realize, however, that I don't have much of a kit available for use in show-and-tell. Most of the excellent solar devices at the Fair were brought here by participants. SO--I am assembling an ALTERNATE ENERGY DEMONSTRATION KIT for use in school classrooms, Chamber of Commerce meetings, demos for business groups, etc. I could use help of all kinds getting this kit together. If anyone has any small PV panels they would care to donate, and/or any solar devices, it would really help. I would like to have a small solar pump, a working model of a parabolic concentrator/Stirling engine unit, a turbine small enough to make power using the water flow from a science classroom tap, maybe a model car run on a few PV cells--things to turn on the kids (and the kid in everyone). Plus I would like suggestions--are any of you out there doing this already? Please let me in on your experience. I would like to assemble the best show possible for the important job of convincing people to go over to alternate energy.

It feels like the time is ripe. We are being asked for our input by people who know things must change, but don't quite know how to change them. If we act quickly, we could have demonstrations like this going on in schools all across the country. If any of you can help in any way, with donations of equipment or money, or suggestions about where to get same, or suggestions about how to put together a show, please let me know. Thank you.

Access

Michael Traugot, 84 The Farm, Summertown, TN 38483

COME VISIT WITH THE HOME POWER CREW AT THE MIDWEST RENEWABLE ENERGY FAIR AMHERST, WI ON AUG. 17,18 ,& 19.

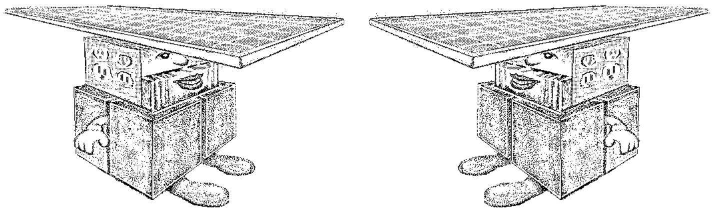
UTILITY
FREE
CAMERA
READY

WILLITS
SEER '90
FULL PAGE

COME VISIT WITH THE HOME POWER CREW

WILLITS
SEER '90
FULL PAGE

System Shorties



System Shorties are brief notes from readers about their home power systems. To join the party, send material similar in spirit to what you see here. We will edit for clarity and conciseness.

Retirees Choice

It seems to me many elderly and retiring people invest their hard earned savings in the large, spacious house they've long dreamed to own when they no longer may need it, so let me give a plug for the compact, solar electric home as a choice for retirees.

My own Social Security benefits are projected to be $522/month, scheduled to begin late next year and me intending to live within my means. I moved off the grid and into my small, but light and airy, 840 square foot house on 8 acres in the central California foothills about six months ago.

Beside spending $22,500 for land and $36,117 on house, garage, septic, water well and 1500 gallon tank and access road, my investment in six Hoxan PV panels, eight golfcart batteries, a Trace C-30A controller, a Trace 2012 inverter/charger, an SDS well pump, 12VDC and 110 vac breaker panels, wiring and mostly fluorescent lights amounted to $5,693.

As such, I pull in as much as 138.6 amp hours/day and generate sufficient electricity for lights, stereo, TV, well pumping and nearly all my cooking.

I also spent an additional $1,150 on a near new, but not yet utilized, 4.9kw Onan generator and $1,015 on a new Servel refrigerator.

I burned less than one cord of wood in my small stove this winter and it now appears my propane consumption for refrigeration, hot water and supplementary space heating and cooking will average less than 18 gal./month.

Thus, a single, elderly person in need of some medical insurance perhaps, but with no extravagant taste or habits and keeping a most detailed record, my present monthly expenditures are as follows:

Basic food & drinks - $125.00
Utilities, propane, & telephone - $37.00
Gasoline & 4x4 truck maintenance - $36.00
House & truck insurance - $56.00
House & property tax - $48.00
Shoes, clothing, books, etc. - $35.00
Monthly total - $337.00

Now from my house situated at 4,000 foot elevation, able to see 170 miles on a clear day and over looking perhaps a quarter million people, 10% of which believe it is necessary to make ten times that much to make ends meet, I find myself content. The sun, most splendid, works for me.

Dag Heistad, POB 788, Soulsbyville, CA 95372

A System at Whales Walk

Our home is powered by a hybrid PV, wind and LP-gas fueled generator system. We have:
16 - Kyocera 40 watt panels
1 - Bergey 100 1-kw wind generator on a 60 foot Rohn tower
1 - Onan CCK5.0 5 kW 1800 RPM genset fueled by LP-gas
1 - Trace 2500 watt inverter
1 - Peter Dahl Co. 117vac to 240/120vac transformer
8 - 6 volt, 305 amp-hr. Surette batteries in 24 volt output
1 - Solahart 160 hot water system

My wife and I installed and maintain the system ourselves. We improved upon the less than satisfactory results from the East Coast USA alternative energy company which dithered around for months after we arrived here. After 18 months, we are finally seeing success. By taking control of the situation, educating ourselves, and ignoring the advice of several profit-oriented, "self-appointed experts" within the AE industry in the USA, we now are completely independent and operate 24 hours per day on the AE system.

Our 3,000 square foot home has ceiling fans in each room, a 20 cubic foot refrigerator with ice maker, a 16 cubic foot freezer in the basement, water pump, 24,000 gallons of cistern capacity, lots of ham radio equipment, and outside lighting. Our AE system is almost transparent to us. Yes, there are times that the lights dim out, when the freezer and refrigerator are in their defrost cycles and the water pump kicks in, and there are days when the wind is calm and the total 14.5 KW design capacity of the collection isn't realized. However, the alternative was paying $36,000 for connection to an unreliable government utility system.

Your magazine has been of invaluable assistance to us, we read our borrowed copies of Home Power as if they are text books in a university course on energy self-sufficiency. The mixture of advice and new product reviews are excellent. Even the advertisements are educational.

Some Kudos for HP advertisers and the AE industry:

1) Real Goods worked very hard to get us a battery charger, in spite of the efforts of their air freight company to send the charger to Timbuctu, our VISA card company to not pay Real Goods, the US Customs Service in Puerto Rico to foul things up, and interruptions caused by Hurricanes HUGO and IRIS.

2) Our Bergey 100 Wind Generator has worked without a glitch, went through Hurricane Hugo with wind gusts measured at 110 mph, and continues to pump out the kilowatts. However, we are not anxious to raise another 60 foot tower during 25 mph winds, in this life or on the next 100 turns of the wheel. While Up There, I kept saying "I want to come back next time as a bird, yes, a small bird, oh, my, even as a tiny creature of the forest will do.....OOOOooooommmm......." You get the picture, I'm sure.

3) Although our Trace inverter failed after only 5 months of use, and we were forced to purchase another one immediately (in order to keep the house alive), the Trace people were helpful and spent a lot of time on the telephone with us.

4) The Onan Company, both at the head office and their factory representative in St Thomas, have performed above the call of duty. The Onan 5.0 CCK genset now has 2600 hours of operation over that last 18 months, without a glitch. About 800 hours were operated on leaded gasoline, 81 octane; 900 hours on unleaded 93 octane marine fuel and the remainder on LP gas. Amazing how clean the spark plugs and the air are after LP gas operation. It only operates about 1 hour per week, just to keep the oil stirred up.

5) The Government of Anguilla deserves a big salute, since they amended the the customs regulations to permit duty free entry of alternative energy and water heating equipment. This saved us 25% of the cost of our system and shipping charges.

6) The Peter Dahl Transformer Company for quickly and inexpensively engineering, manufacturing & shipping a transformer to convert the 117 volt 2 wire output of the Trace to the standard 240/120 3 wire service of our house system. Real professionals.

Buttkicks (Boots in the rear?) for some AE "experts":
1) The Surrette Battery people for shipping batteries without electrolyte and without instructions. This resulted in the batteries being supplied locally with electrolyte of 1.210 specific gravity instead of 1.265. We couldn't figure out why they would never come up to full charge. After 8 months of problems, a ham radio friend recommended adding some concentrated acid, bringing the specific gravity up to 1.265. Worked like a charm. The Surrette people don't answer their mail either.

2) The Bergey Company, for originally supplying us with a used EMS1000 controller for the wind generator. It was built for another system, then "modified" to work with our 24 volt system --all without our knowledge. It took 5 months to figure that one out, and to get them to exchange it for a properly manufactured 24 volt controller.

3) The Trace Company, for placing those tiny little allen-head terminals inside the inverter. There just isn't enough clearance for wires, fingers, terminal rings. We still operate our Trace inverter using the accessory plug on the side, wired into the transformer. That's just plain stupid engineering.

4) The Para Systems company for telling me that their "Minute Man 300" computer uninterrupted power system would work with an inverter. I bought two of them for my consulting work stations, and they will not work. They go into fault due to the non-sine wave output of the Trace Inverter. Para Systems people don't answer their mail from us, either.

Final results: We are now assisting 5 local people with the selection and installation of wind generators for 12 volt production. Their systems are on order and we are waiting for the boat to arrive. One person's antique Wincharger 12 volt 200 watt machine is being reconditioned after years of storage. In the 1930's and 1940's there were an estimated 15 wind generators on Anguilla, which then had no commercial generation at all.

The next project here is the completion of the island's emergency radio repeater system (callsign VP2EA/R, 147.81 mhz) which will be powered by an innovative twin turbine wind generator from Ted Baer of Enercraft. Planning for 1991 includes using surplus 200 watt Winchargers on 64 foot towers to power a local service station and installation of a Bergey 3KW synchronous, grid connected system for a local business. Future planning includes locating a surplus electric powered van in the USA and operating it here in a feasibility test, using a Wincharger or Enercraft system to charge the batteries at night. Considering that the island is only 16 miles long, an electric vehicle may be an interesting and very useful concept. Gasoline is about $2.50 per gallon, not to mention pollution.

Anyone out there who would like to give advice, information, trade ideas or donate a surplus electric van can contact us anytime.

Best Regards, and good luck in the future.
Dave Mann (VP2EHF) & Dorothea Mann (VP2EE)
Whales Walk, Little Harbour, Anguilla Island, B.W.I.
809-497-2150 (FAX and Voice)

Solar Cool

We must compliment you on your straight forward, intelligent information your magazine presents. Also we love your writers' sense of humor ... much needed in this hectic world of today!

We have a brand new solar home (nearly 1/2 completed). Our energy comes from 8 Solarex MSX-60's which powers our home for all our current electrical needs, except for our gas refrigerator & stove (stolen from our camper).

Your magazine has really been the "light of our life" in helping us make decisions and installing our solar system.

Our twenty acres of raw desert land did not come equipped with APS (grid power) and since we were located nearly 3/4 mile from the nearest utility hook-up we decided it would be much more cost effective to go "Solar Power". We were right.

We have suffered plenty, enduring temperatures of over 115° while building our home. Summers here in the Sonoran Desert are nearly unbearable and for 3 years we endured the summer heat - UNTIL THIS YEAR.

We have just installed a new 24 volt cooler! We changed the pulley to a huge 18 inch, so now our 1/2 horse DC motor pulls 6 amps (1 amp over motor running free!). We are pretty impressed with our cooler power usage of only 144 watts! Yesterday, for example, the outside temperature climbed to a soaring 114° and our cooler kept us at an even comfortable temperature of 80°. Humidity was at 7%, which really helped the evaporation work. WOW, 34° difference at 144 watts of DC solar power! I just wish more people would give solar a chance to show what it can do.

As money comes, we plan to expand our PV array and battery capacity (now at 440 Amp-hours storage). We feel we are 1/3 the way there to all the eventual power we will need.

At present, we power our cooling system, color TV, VCR, stereo, Kenmore large capacity washer, all lights PL, cellular DC phone, typewriter, compressor, microwave and a large outdoor yard light (75 watt) to the barn. Of course, all is used in moderation during certain times of the year, but I must add we "get a feel" for the power made available to us during a given day. Conservation is the answer from the beginning. As you add one energy efficient product after another, it finally all adds up, and in our case, we don't do without - we just conserved from the start.

We hope in the future, we can inspire others who really care about our country's energy/waste and would like to join the positive side of solar power. Many thanks to you in your efforts of "showing us the way" and a word to let you know we are grateful.

Bruce & Laine Brekke, Maricopa, AZ

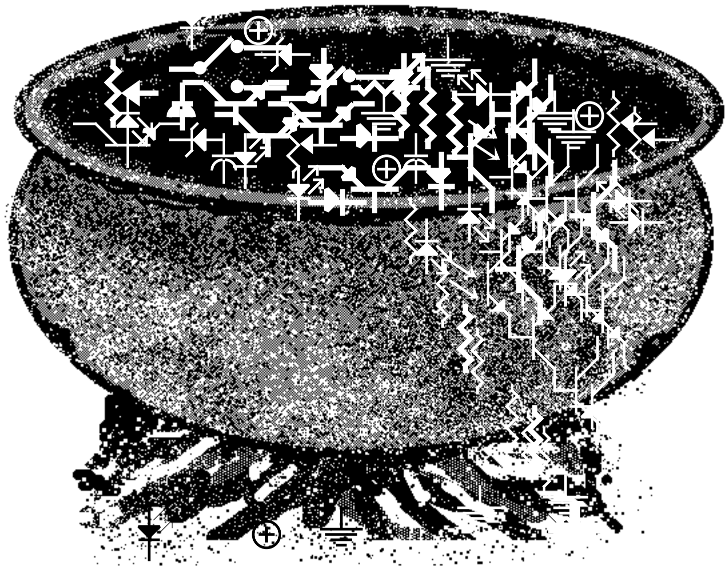
A Silly Short Shortie

I am writing to thank you for the inspiration you provided which led to my installing a sixteen-panel PV-system in my remote home.

Now, when I arrive, I can take a ready meal from my Sunfrost freezer, pop it into my microwave oven, turn on the DC television and VCR and feel just like at my old house in Levittown, PA.

Sincerely yours, Marvin Kleinkopf, Big Bluff, CO

Homebrew



Shunt Regulator

Chris Greacen

Wind, hydro and photovoltaic panels can sometimes produce more electricity than our batteries can store. Overcharging batteries increases water loss in the electrolyte, decrease battery life; and is potentially more dangerous. Under charge, the voltage of a fully charged battery system can rise to levels which will fry 12 Volt electronics (including some inverters) attached to the system.

There are two basic kinds of regulators: series regulators and shunt regulators. Both regulators have a sensing circuit which regulates current flow into batteries when the voltage exceeds a threshold level. Series regulators work by switching off current from the charging source (panels, etc) when the voltage climbs too high. With the charging source disconnected like this the battery voltage sinks to its standing voltage (lower than its voltage under charge). Series regulators are simple, but they have two disadvantages: first, not all power potentially produced by the power source is used. When the load is switched off, generators used in hydro or wind systems can spin more quickly than they are designed for and destroy themselves. This does not apply to solar cells - running Pvs open circuit, or short circuit for that matter, does no harm.

Shunt regulators work by diverting the power from the batteries into some other load. In effect they waste electricity, but wasting electricity is much better than overcharging batteries - or destroying electronics. Of course if you do have a way to put those electrons to a good use, by all means do it - run the washing machine or vacuum cleaner.

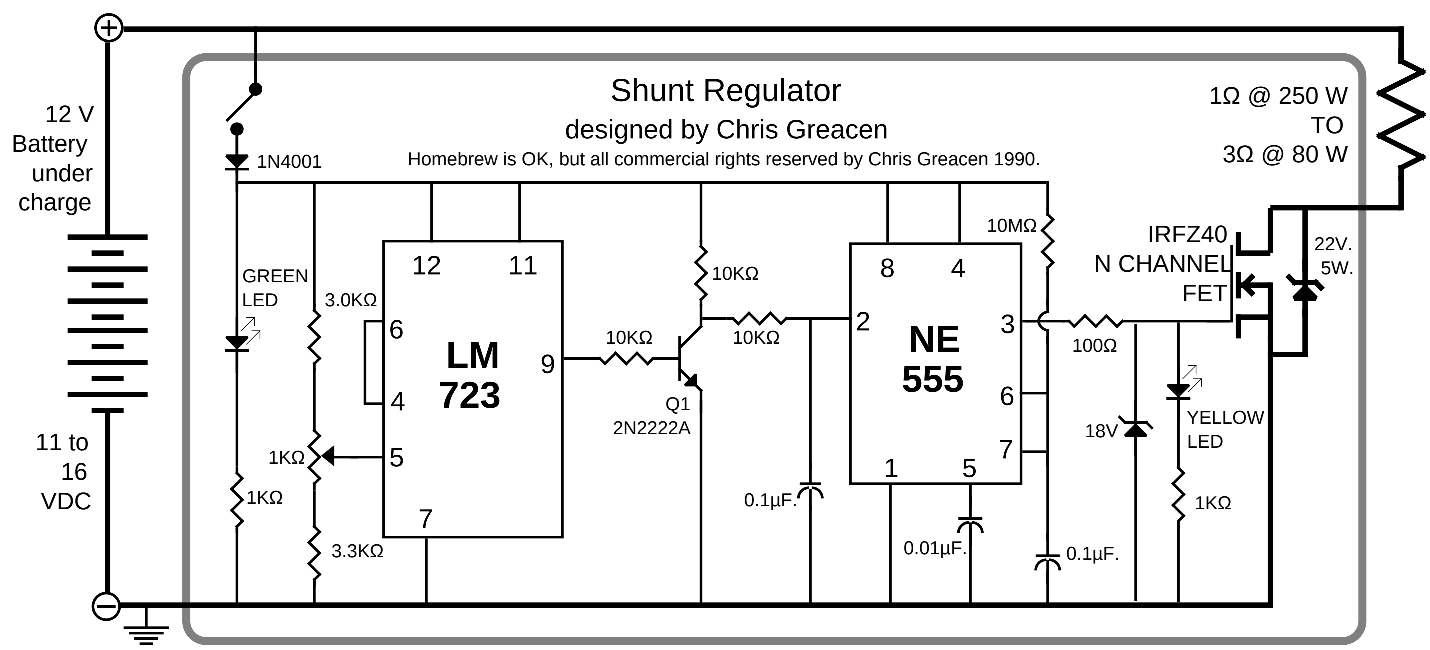
What follows is a working, simple shunt regulator. With a proper load, this shunt regulator can regulate up to 15 Amps (more than 3 Kyocera J-48 PV panels on a very sunny day).

How it Works

The threshold voltage is determined by the potentiometer on the voltage divider into pin 5 of the 723 (refer to the schematic). When this voltage exceeds the 723's internal reference voltage (pin 6), pin 9 goes high saturating Q1. The 10kΩ resistor and 0.1µF capacitor assure that the power FET does not make the ON-OFF-ON transition too fast. When the capacitor on pin 2 is discharged to 1/3 Vcc the 555 is triggered and pin 3 stays high for a time period determined by the resistor to Vcc and capacitor to ground on pins 6 and 7: time ≈ 1.1RC ≈ 1.1 seconds. Pin 3 feeds the gate of the FET, protected against over voltage (Vgatemax= 20 Volts) by an 18 Volt zener. When the gate goes high the FET conducts, sending full current through the shunt load. A 5 Watt, 22 Volt zener diode protects against voltage spikes from inductive loads. The two LEDs help see what the electronics are doing. The green LED is on whenever power is on. The amber LED lights whenever the regulator is diverting power to the load.

Construction and use information

In the schematic dark lines indicate high current carrying wires. To avoid overheating on these use 16 gauge or larger wire. For a load



I suggest using high wattage power resistors since reliability of the load is the primary consideration. Using a bunch of car tail lights in parallel would also provide a good load since chances are excellent they will not burn out at once. Here is an example for determining resistance and wattage. Suppose the maximum current I wanted to regulate was 15 Amps at 15 Volts. Since R = V/I we need a resistance of 15 Volts/15 Amps = 1.0 Ω. Wattage is given by P = IV. P = 15 Amps * 15 Volts = 225 Watts. To be safe, I'd use 250 Watts.

When hooking up your regulator make sure the system's voltage is below 16 VDC since the NE555 is rated at a maximum 16 Volts. The regulator will regulate voltages from 12.0 to 15.8 Volts. When hooking up your shunt regulator it is a good idea to hook up the load first and make sure there are no short circuits.

Access:

Chris Greacen, Box 229, Reed College, Portland OR 97202

For Power resistors:

Hosfelt Electronics Inc. 2700 Sunset Boulevard, Steubenville, OH 43952; tel 1-800-524-6464

Quartz Halogen Lighting

Wally Skyrman

Upon reading in HP #15, page 31, the Wizard's Micro PV System, I think I know someone else who could use quartz halogen incandescent lighting. In past issues of HP reference was made to quartz halogen lamps and their efficiency, but until I got distracted with the RF static generated by my fluorescent lighting I never gave it much thought.

Like the Wizard, I like to use my radio, especially AM and shortwave, at night. I needed an efficient light that didn't interfere with my radios. In a nutshell what I did was to take one of the swing arm desk lamps and, by use of a converter, place a 20 watt, 12 volt quartz halogen lamp in place of the stock 100 watt, 110 volt energy burners.

The heart of the lamp is the bulb. Quartz light spectrum is very close to sunlight. 3000-3200 degrees and is nice to work with. The lamps come by themselves or with a built-in reflector. If you have ever relamped a Kodak Carousel slide projector you have dealt with the big brother of what is pictured. Instead of 300 watt-120 volt we will use 20 or 50 watt-12 volt bulb which is sold for low voltage track lighting. There is one hazard in using this style of bulb. It can break and explode in operation, therefore the fixtures designed to use this bulb have a glass lens sealing off the bulb.

Parts List

Swing Arm Desk Lamp - Any department store, Pay & Pak, K Mart, etc. $11. I used a Grandrich Model G-2512. Try to find one where the reflector bowl is in two pieces. This helps in working on the lamp after the front shield is in place.

Quartz Bulb - Electrical supply houses and some HP advertisers. Like projector bulbs, these lamps come with a three letter code. You

Above: BAB model Quartz-Halogen indandescent lamp made by Philips, Model "Accent 1200". This particular one consumed 1.8 Amperes at 12 VDC (measured by Fluke 87).

Left: The Grandrich Model G-2512 swing arm lamp with the Quartz-Halogen lamp installed.

Photos by Richard Perez

will want a BAB for the 20 watt or EXN for 50 watt. I used a BAB model made by Philips, Model "Accent 1200" that cost $9. These seem to be the most commonly available flood style that are stocked. Others are available, but I have no experience with them. Price is $6 to $10.

Adapter - These bulbs will not screw into the lamp without an adapter. HP advertisers that stock halogen bulbs also have the adapters you will need. In my case, I already had the bulb and, it being a weekend, I fashioned small brass connectors to do the job.

Shielding - Not wanting hot glass raining down on me in the event of bulb explosion, I took the plastic from an old motorcycle helmet face shield and by using tin snips, cut out a disc that would snap into place. With the two piece reflector I was able to screw in the adaptor, insert the lamp and replace the reflector/shield. By installing an appropriate 12 VDC plug I was in business. No more whistles while listening to KGO, KOA or Radio Netherlands...

Access

Wally Skyrman,4588 Pacific HWY N, Central Point, OR 97502

Another Sewing Machine Fix

Larisa Walk

I've been meaning to write about sewing machines and was finally prompted by the article on converting a sewing machine to hand power in the June/July issue.

From Electric to Treadle

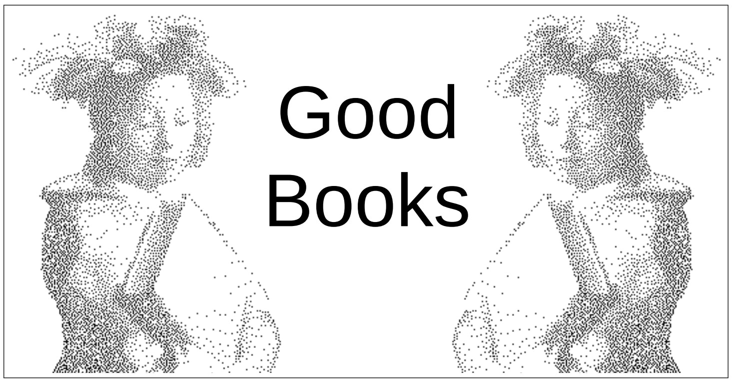
I have a somewhat unusual treadle sewing machine - a hybrid of old and new technology. The machine is a Bernina #807 and the cast iron base is a Singer industrial treadle. To accomplish this union required only a hacksaw and a little nerve as I cut away part of the metal casing around the base of my $600 Swiss-built machine, exposing the drive wheel. I removed the drive belt that connected to the electric motor and made a leather drive belt to fit around the treadle wheel. The machine itself sits on a wood table that is bolted to the treadle base, with a hole cut off from an old standard machine.

The first treadle base I had was a cast off from an old standard machine, The drive wheel on most of these machines is 12" diameter, which is OK for straight stitching but too slow for zigzag or pattern stitches. I later found the industrial base with a 16" diameter drive wheel. It was holding up a flower planter in someone's yard and was quite rusty. I stopped and talked to the man who had it and offered to swap my nice painted base for his rusty one. Needless to say, he must have thought I was a little nuts but agreed to my proposal.

Twelve Foot Powered Years

I came up with this combo long before I moved off the grid. I originally learned to sew on an old treadle when I was 6 years old, and as a professional seamstress I wanted to recapture that precise control over the needle action without giving up the pattern stitches of my modern machine. The only part of my machine that I would ever consider hooking up to 12V would be the built in light bulb. I've had the Bernina for 15 years, 12 of which were treadle powered. Anybody want a slightly used 110 vac sewing machine motor?

Access Larisa Walk, Rt3 Box 163A, Winona, MN 55987



Solar Electric Independent Home

by Paul Fowler

reviewed by Ann Schuyler

My husband and I just recently joined the ranks of PV'ers. There are a few of us here in southern Vermont and we circulate a subscription (1) of Home Power among us.

I am writing to tell you of a GREAT new book that helped us tremendously when we were building our remote home and choosing just the right PV system for our needs. We thought you would put something in your magazine about it, since you are dedicated to getting the word out about new products, etc. to your readers.

The book is The Solar Electric Independent Home Book and is written by Fowler Solar Electric Inc. of Worthington, MA. The copyright date is 1989; I note that there is no ISBN or Library of Congress number. We purchased our book directly from Fowler Solar Electric, Inc. We bought our system from FSE and also bought the book at the same time, mainly because it was recommended that we do so and we did not know that much about the "technical end" of the PV system we were installing. Well, after reading The Solar Electric Independent Home Book, we were able to design our system and know that we were getting exactly what we needed to power our home. We were also able to cut down a great deal on our electrician costs, because we did a good part of the installation by ourselves. Now, we are enjoying our system and know what to do during those low sun months and can troubleshoot our own system. It is just a good feeling to know we are able to rely on ourselves for our own power and taking care of our PV system. We couldn't have been able to do this had we not found out about Fowler Solar Electric's book.

In any event, since you are on the West Coast, you may not know about The Solar Electric Independent Home Book. If you want to order one, the cost is $15.95 and is available from:

Fowler Solar Electric, Inc.

13 Bashan Hill Road

Worthington, MA 01098

The phone number is 413-238-5974 and there is probably a shipping charge. Ours was mailed with our system, so I am not sure what the shipping cost would be. It would be nice if you included my letter in your next issue, or see for yourself by ordering the book!

Neighbors- Electric Burro on the Road to Bogota

by Scott Hudson

reviewed by Kathleen Jarschke-Schultze

The title of this book is somewhat misleading. There is no burro on the road and the Bogota mentioned is in Tennessee. The facts are that author, Scott Hudson, left an unfullfilling job as an air traffic controller to traverse 1,350 miles in the world's first solar outfitted, computerized Mennonite made buggy to commemorate the 50th anniversary of the Rural Electrification Administration.

Horse power for the buggy was provided in the form of Carter, a Belgian draft horse, purchased for the journey three days before it began. Scott has never been around horses and is apprehensive about Carter in the beginning.

The tale that unfolds is man and horse getting to know each other and the both of them meeting the "Neighbors" of the title. Neighbors being regular Americans who helped Scott and Carter along their route. They encounter many people who become friends through their help and interest. Scott says, "If you want to travel and make friends, take a horse with you."

If you are a horsey kind of person or just want to be entertained by true vignettes of Americana this is the book for you.

Available from: Breakaw a y Publications, 8344 old M-72, PO Box 169, Williamsburg, MI 49690. Hardbound $16.95 Softcover $4.95

SHELTER

Lloyd Kahn, Editor

reviewed by Richard Perez

Ever think that a rectangular box wasn't your dream home? Well, here is a book that provides hundreds of housing concepts, and not one of them is a box. Everything from mud huts to hi-tech is visually displayed in this gargantuan book. Once I started it, the rest of the day was shot. I flipped from one housing reality to the next. I started having dreams about a home I might someday build. This book stirred my imagination. It made me see the relationship between sensibility and structure.

Shelter is a huge book filled with home design information and inspiration. It is the combined work of many folks. The large format (11" X 14.5"), 176 page, book is filled with hundreds of pictures. Pictures of just about every kind of home design imaginable. And all of them are accessible to self-builders.

Don't expect Shelter to deliver plans and construction details. Shelter is conceptual. It will provide you with fresh ideas from alternative architectural realities. Don't build a box before seeing this book. Shelter will provide you with the inspiration to build a home as unique as you are.

You can get Shelter from Ten Speed Press, POB 7123, Berkeley, CA 94707. ISBN# is 0-89815-364-6. Cost is $16.95 per book plus shipping charges of $2.50 for the first book and $1. for each additional book.

GLOSSARY OF HOME POWER TERMS

compiled by Scott Hening

ac motor
an electric motor designed to operate from alternating current.

active solar
generally refers to a system which uses the sun's energy through direct conversion to electricity.

alternating current (ac)
an electrical current in which the current periodically reverses its direction of flow. Most household electrical systems use ac current rated at 120volts and 60 cycles per second, where 1 cycle refers to 2 complete reverses in direction of the flow.

alternator
an electrical generator which produces alternating current.

ammeter
a device used for measuring current flow at any point in an electrical circuit.

ampere-hour
a unit of measurement which quantifies an amount of current flow for an amount of time. For example, a current of 1 amp drawn from a battery for 10 hours would consume 10 amp-hrs of charge from the battery.

ampacity
refers to the highest amount of electrical current which may flow through a conductor (wire) safely. Ampacity is determined by the cross-sectional area and the material of the conductor.

ampere (a)
a measure of electrical current quantifying the amount of electrical charge (coulombs) passing a point per unit of time (1 amp = 1coulomb/sec).

amplitude
generally refers to the maximum and minimum voltage attained by an alternating or pulsed current in each complete cycle or pulse of that current.

anode
the electrode within the cell which undergoes the chemical process of oxidation. Electrically, the anode is the cell's positive terminal.

antenna
a metal rod, wire, or bunch of wires used for radiating or receiving radio waves.

AWG
American Wire Gauge, a set of standards specifying the diameter of wire.

ballast
a circuit used to stabilize an electric current, for example, in a fluorescent light.

battery
a group of interconnected electrochemical cells. Single cells are considered to be a battery if they are used alone.

blocking diode
an electronic device inserted between the PV panels and the batteries which blocks electronic flow from the batteries to the panels after dark.

BTU
British Thermal Unit:
a unit of energy commonly used in heating applications. 1 watt-hr = 3.413 BTU.

buss
any conductor into which voltage is supplied and from which many lines to household loads extend.

cathode
the electrode within the cell which undergoes the chemical process of reduction. Electrically, the cathode is the negative terminal of the cell.

charge controller / regulator
a device which regulates the voltage of a battery. These may be used to assure a battery is not overcharged and/ or overly discharged.

charge rate
the amount of energy per unit time that is being added to the battery, commonly expressed as the ratio of rated capacity to charge duration in hours

continuous output rating
refers to the maximum amount of power an inverter may deliver to a load (or loads) for a sustained period of time.

current
refers to electrical current, i.e. the flow of the electrons, electricity.

cycle
one complete charge/discharge cycle of the battery

DC brushless motor
an electric motor using permanent magnets and operable from direct current electricity.

deep cycle battery
a battery designed to regularly discharge 80 percent of its capacity before recharging.

depth of discharge or cycle
the amount of energy withdrawn from a battery or cell expressed as a percentage of its rated capacity

DHW
Domestic Hot Water: refers to any system which provides hot water for household use

digital multimeter (DMM)
a device with multiple electrical measurement capabilities, such as: voltage, amperage, resistance, etc., commonly usable for both ac and DC circuits. It has a digital readout

diode
a semiconductor device which allows electrical current to flow through it in only one direction

direct current (DC)
an electrical current which flows in one direction only

discharge rate
the amount of energy per unit time that is being drained from the battery

duty cycle
refers to the fraction of time a device or load actually draws current in a unit of time, for ex. a load that draws current for 5 seconds out of every 10 seconds has a 50% duty cycle

efficiency
refers to the effectiveness of a device to convert energy from one form to another, or to transfer energy from one body to another. Ex. a solar cell which converts 1/10 of the sun's energy which strikes its surface to electricity has an efficiency of 10%.

electricity
the flow of electrons

electrolysis
the breaking down of a chemical compound into simpler compounds or elements by the passage of electricity through the chemical compound

electrolyte
the medium of ion transport within within an electrochemical cell. It provides a path for electron transfer between the anode and cathode of the cell.

electromagnetic radiation (EMR)
magnetic radiation produced by a changing electrical current, such as alternating current (ac)

electron
a fundamental particle of an atom which carries an electrical charge of 1.6×10^{-19} coulombs.

energy
an attribute of a system or entity which quantifies the amount of work which that system or entity could do (potential energy) or is doing (kinetic energy), measured in joules.

energy density
a ratio of a battery or cell's capacity to either its volume or weight. Volumetric energy density is expressed in watt-hrs/cubic in. Weight energy density is expressed in watt-hrs/pound.

engine
a machine which converts energy into mechanical force or motion. Sources of energy include: heat, chemical reaction, nuclear, potential energy of elevated water, etc.

equalizing charge
a controlled overcharge of an already full battery to restore all the individual cells within the battery to the same state of charge

FCC
Federal Communications Commission: Determine the rules and regulations governing the use of radio, television, and many other mediums of communication

feathering
in wind generators, this refers to an adjustment of the blades so that they catch less wind. This can prevent damage to the windplant in high winds.

flow
in hydro-electric terms flow refers to the quantity of water supplied to a water source or exiting a nozzle per unit of time. Commonly measured in gallons per minute.

Fluorescent light
an electric lamp coated on its inner surface with phosphor and containing mercury vapor. When bombarded with electrons, the vapor emits ultraviolet light which, in turn, causes the phosphor to emit visible light.

fuse
an electrical device which is designed to break a circuit and halt current flow when the current in the circuit exceeds the maximum considered to be safe for the conductors or devices in the circuit

generator
a device which converts mechanical energy into electrical energy

governor
a device which limits the output of another device, such as a wind generator

grid
refers to electricity produced and delivered by a commercial power utility

ground rod (electrode)
a metal rod (typically 5/8" diameter) which is driven into the earth (typically 8' deep) and is electrically connected to the negative line and/or any large metal parts of an electrical circuit.

head
the difference in elevation, in feet, between a source of water and the location at which the water from that source may be used

heat pump
a device typically used for heating and cooling of buildings. When cooling, a heat pump works like a refrigerator. When heating, it also works like a frig, except the heat produced (as from the cooling coils on the frig) is used to heat a space

hertz (Hz.)
cycles per second. Generally refers to the number of complete cycles of the sinusoidal ac waveform per second

hydro-electricity
any electricity which is generated by the flow of water

incandescent light
an electric lamp which is evacuated or filled with an inert gas and contains a filament (commonly tungsten). The filament emits visible light when heated to extreme temperatures by passage of electric current through it.

insolation
the amount of solar energy striking a surface, measured in watts per square meter (SI)

inverter
a device which converts DC voltage/current (typically 12, 24, or 48 VDC) to ac voltage/current (typically 120/240 vac)

jack pump
a submerged pump mechanically activated by a rod at the well head.

joule
the standard unit of energy (SI)

light emitting diode (LED)
a semiconductor device composed of a pn junction designed such that electrons emit visible light during their migration across the junction

line/wire loss
refers to the voltage or power lost due to the resistance of any wire (or wires) in any electrical circuit

linear current booster (lcb)
an electronic circuit that matches PV output directly to a motor. Used in array direct water pumping.

load
refers to any electrical device which draws electrical current from a voltage source, for ex. any household appliance

lumen
a unit of measurement quantifying the amount of light emitted from a light source

micro-hydro
hydro plants producing more than 100 watts and less than 2000 watts

motor
a device which converts electrical energy into mechanical energy

nano-hydro
any hydro plant which produces less than 100 watts

National Electric Code (NEC)
an organization which determines the legal standards for household wiring with safety as the prime objective

ohm (Ω)
the unit which quantifies a material's resistance to electrical flow

open circuit voltage
refers to the voltage difference of two points in a circuit when the two points are electrically disconnected from each other

parallel connection
an electrical circuit with more than one possible path for electronic flow

passive solar
refers to any use of the sun's energy in a manner which is found in nature. For ex., heating a thermal mass (a concrete wall or slab, for instance) during the day, and using the stored heat in that mass to warm a greenhouse or home at night.

peak watts (Wp)
the maximum power a device produces or consumes

pen stock
the area where water is collected and fed into the pipe of a hydro system.

phantom load
a device which consumes power even when its power switch is off, such as the digital clock on a VCR

photovoltaic (PV)
refers to any device which produces free electrons when exposed to light. When these electrons are properly gathered, a potential difference (voltage) may be produced by the device, for ex. a solar cell produces approx. one half volt in full sun.

pipe loss
the amount of energy or pressure lost, due to friction with the inside surface of a pipe, when water flows through a pipe

polycrystalline cell
a wafer of silicon with a multi-grained structure. All grains have the same atomic crystal lattice, however, each grain has a unique orientation in space thereby producing a unique reflection of light, resulting in a "patchy" appearance.

power
describes the rate of energy use per unit time, measured in watts, i.e. 1watt = 1joule/sec

pulse width modulation
when speaking of pulsed (or alternating) current, this is the intentional variation of the time duration of each pulse (or each half-cycle pulse in an inverter)

PV array
two or more photovoltaic panels wired in series and/or parallel

quartz-halogen light
an incandescent lamp filled with halogen gas.

radiotelephone
a two way radio system that enables use of a regular telephone but with radio instead of wires.

rated capacity
the amount of charge which may be stored in a battery, commonly expressed in amp-hrs.

renewable energy
Any type of energy which may be renewed by natural ecological cycles or appropriate management practices

resistance (Ω)
refers to how well a material conducts a flow of electrons, measured in ohms (Ω).

resistor
a device with a known amount of resistance used in electrical circuits

RF (radio frequency)
any radiation of a frequency which may be received or radiated by radios. Common usage: RF interference; refers to the interference of radio frequency radiation with the operation of devices or appliances such as televisions, computers, etc.

RMS
Root-Mean-Square: defines a time averaged value of a sinusoidally varying parameter such as ac current, voltage, or power.

rotor
the blades of a windplant which are shaped to spin when exposed to wind thereby harnessing the wind's energy

self-discharge
the tendency of all electrochemical cells to lose energy. Self-discharge represents energy lost to internal chemical reactions within the cell.

series connection
an electrical circuit with only one possible path for electronic flow

series regulator
a device which prevents overcharging of a battery by disconnecting the charging current as the battery voltage approaches some upper limit

short circuit current
refers to the current which passes between two points in a circuit when the points are electrically connected with a conductor with essentially zero resistance

shunt
a resistive load through which electricity is diverted. Often the resistance of a shunt is known precisely and is used to determine amperage by measuring the voltage across it and using Ohm's law (I = V/R)

s**hunt regulator**
a device which prevents overcharging of a battery by diverting some (or all) of the charging current to a resistive load when the battery voltage reaches some upper limit.

single crystal cell
a wafer of silicon which has a perfect, continuous, crystal lattice (on the atomic level)

site evaluation
an estimation of a location for its potential for solar, hydro, or wind power.

solar cell
one silicon (or other semiconductor) wafer, appropriately processed and electrically connected for gathering free electrons. Generally, many wafers are connected in series and assembled in a photovoltaic panel.

solar cooker
a device which converts the sun's energy into heat energy, which is then used to cook food

state of charge (SOC)
a ratio, expressed in percent, of the energy remaining in a battery in relation to its capacity when fully charged

surge capacity
refers to the maximum amount of ac power an inverter may deliver to a load (or loads) for a short period of time

switch
a common device which breaks an electrical circuit thereby halting the flow of electricity through the circuit

thin film
a PV manufacturing technique where silicon is vapor deposited, a few molecules thick, onto another material (usually steel).

tracker
any device used direct a PV array towards the sun

trash rack
a large strainer at the input to a hydro system. Used to remove debris from the water before it enters the pipe.

turbine
an engine which produces rotary motion through reaction or impulse, or both, with fluid under pressure. In hydro systems, the resultant rotary motion is usually used to drive an alternator generator.

volt (V)
the unit of measurement which quantifies the difference in the strength of the electric field of two points -often referred to as electrical potential difference or potential difference.

voltmeter
a device for measuring the voltage difference between any two points in an electrical circuit

watt
a fundamental unit of measurement of power, 1 watt = 1joule/sec

watt-hour
a unit of measurement quantifying an amount of power used, or absorbed, for an amount of time. A load which consumes 1 watt for 10 hours uses 10 watt-hrs. Fundamentally, a measurement of energy.

COME VISIT WITH THE HOME POWER CREW

AT SEER '90, BOOTH #5, WILLITS, CA ON AUG. 11 & 12

AND AT THE MIDWEST RENEWABLE ENERGY FAIR, AMHERST, WI ON AUG. 17,18 ,& 19.

The Wizard Speaks…

Stability & Order

Goal determines Path. Path determines process. Process is a dynamically changing goal. Dynamic stability is the ultimate necessity for any successful process. Some degree of randomness is necessary for dynamic stability. Both absolute order and total randomness will eventually cause the breakdown of any dynamic process. There is a peak in the dynamic stability vs. relative order. Plot where the ratio of apparent order to apparent randomness is such that the necessary flexibility and choice in path and process is obtained.

The above suppositions are seen in some of the basic theories of physics. One of them, Quantum Mechanics, allows for certain lower probability paths to be taken when conditions warrant. Another, the Heisenberg Uncertainty Principal, allows for the violation of certain basic laws of physics if the space/time intervals involved are small enough. The fact that the mathematics of many theories breakdown at certain points (at the speed of light or in the interior of black holes) indicates that the therories are static rather than dynamic descriptions of reality.

This hypothesis also receives some possible confirmation in the electronic and energy production areas. It is probable that certain advantages inherent in amorphous and polycrystalline solar cells are due to this effect. Any room temperature superconductors must take these concepts into consideration to provide the flexibility necessary for stable operation under room temperature conditions, high currents, or large magnetic fields. Any attempt at alternating pole permanent magnets will also have to consider this effect in relation to the arrangement of magnetic domains. It is to be concluded that any matrix of elements structured to produce a desired effect under conditions of normal reality must have a certain degree of probabilistic randomness in order to maintain dynamic stability.

The randomness in this case is NOT entropic disorder. It is a randomness that contributes to dynamic anti-entropic order. In the case of room temperature superconductors it acts to provide a greater path bandwidth under conditions of higher entropy, thus creating more dynamic order.

This effect can also be demonstrated by the notion that more information can be extracted from a system that is neither totally ordered nor totally random. In computer terms there is more information available from a combination of ones & zeros than from all ones or all zeros. So to obtain dynamic stability- be flexible.

Writing for Home Power Magazine

Home Power specializes in hands-on, practical information about small-scale renewable energy production and use. We try to present technical material in an easy to understand and easy to use format. If you want to contribute info to Home Power, then here's how it is done…

Informational Content

Please include all the details! Be specific! Write from your direct experience- Home Power is hands-on! We like our articles to be detailed enough so that a reader can actually apply the information. Please include full access data for equipment mentioned in your article. Home Power readers are doers. They want access data for the products you mention in your article.

Article Style and Length

Home Power articles can be between 500 and 10,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short and to the point. We like the generous use of **Sub-Headings** to organize the information. We highly recommend writing from within an *outline*. Check out articles printed in Home Power. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing

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

Photographs

We can work from any photographic print. The best results happen if we have a black & white print rather than color. We can work from a negative if necessary.

Line Art

We can work from your camera-ready art. We can also scan your art into our computers, or even redraw it via computer. We usually redraw art from the author's rough sketches. We can generate tables, charts, and graphs from your data.

Got a Computer?

We would like your article on computer disk if possible. This not only saves time, but also reduces typos. We use Macintosh computers. Please format all word processor files in "TEXT" format. We can also read text files on 3.5" IBM disks. Please format the IBM word processor file as ASCII "TEXT". Format all graphics in either PICT, EPS, or TIFF formats. Use the Helvetica 9 point font for all text embedded within graphics.

What your material returned?

Please include a stamped, self-addressed, return envelope. Otherwise your material will not be returned.

Copyrighting

If you request it, we will copyright your work in your name. Otherwise we will copyright the information in Home Power's name. The copyright on your material is yours for the asking.

Got any questions?

Give us a call at 916-475-3179. This saves everyone's time.

RP

Letters to Home Power

We Print 'em Unedited.
Selected & Entered by Karen Perez

More Delco Tips

Dear Home Power, As a long time advocate and user of home power I was pleased when I saw my first issue (#15) of the magazine. I have not been doing much except talking about it for the last seven years for various reasons, but am now teaching a class on wind energy and electric vehicles for Jordan College's Energy Institute.

The letter from Lon Beville about using Delco generators for motors is right on, but here's a few more tips. The variable resistor (rheostat) for the field is needed only if you want to vary the speed of the motor. I've used them for grinders, drill presses, water pumps, etc. by just grounding the field. By use of the rheostat, however, you can run these motors on higher voltages. 24 and 32 volt systems will run them ok, I've never tried higher. The trick is to keep the current in the field to the same level or less than if 12 volts was applied. More current than that is just turned to heat and can burn out the field coils. I took an old Ford generator and mounted it on a 30" buzz saw. Double V-belts from the motor to the flat pulley worked fine. At the time I was using a 30 volt system with a large battery. A rheostat was used to adjust the field current so that the motor drew minimum current and the saw would "sing" right. That was about 10 amps. The wood I cut was slabwood, sometimes I'd have to nurse it and make two cuts, but it worked well. While loaded down cutting hard, the motor would draw about 100 amps. Sometimes I'd smell the hot insulation, but since I had plenty of motors I ignored the odor. Never burnt that thing out, and I cut a lot of wood.

You probably know by know that Mother Earth News built a large Minto Wheel back in the '70's and it was a bust. Took so much heat to make it go that it wasn't worth the effort. It did work, though.

If Home Power is interested I'll write an article on my battery powered arc welder that would lay a 200 amp bead and did a lot of fastening for me. Also, perhaps a description of water systems I've installed.

Meanwhile, here's my six dollars for a subscription, keep up the good work! Oh, by the way, Jordan College's offices are in Cedar Springs, MI 49319.

Paul E. Zellar, Mount Pleasant, MI

Hello Paul, Home Power considers all reader input- articles, system shorties, homebrew, and letters. See "Writing for HP" on page 55 for the details. RP

New Mexico Hydro Freaks, LOOK OUT!

Would like to contact current water power user's in New Mexico. Can you help?
H. Frauenglass, 1316 Willow Farm Box 56, Embudo, NM 87531

More Stamps Than Friends

Hello! I am/was a B.S. Mechanical Engineer, but am also a pragmatist, or is it just intelligently lazy... I am impressed with a lot of the high tech equipment & techniques, many of which I am not familiar with, such as the LCB. On the other hand, I did not find as much low tech as I presently want.

However, I did find helpful data for solar hot water -- and perhaps will plan on a fancier system which would also supply more hot water during the winter than the current method -- which is basically black plastic pipe on the roof pumped thru the existing propane HW tank to keep it full.

RE back issues: have you a descriptive index which could make possible selection of WHICH back issues are desired? Have you reprinted and bound back issues for sale? Or even considered doing so? I can see just from #17 that selection of material for reprint might require savage ruthlessness or perhaps ruthless savagery........

Now a new purpose in/for life: existing till the arrival of the next issue. Thank you, thank you, thank you! You may publish any of this you like, w/name and address. I have more 25 cent stamps than friends, and am a medium fast typist...

Best regards, Woody Mcpheeter, 3095 Galls Creek Rd, Gold HIll, OR 97525

Hello Woody, we're working on solar hot water articles, but we need input from readers to accomplish this in print. No one in the crew now has a solar hot water heating setup, but we are aware of several, notably the Copper Cricket from the Sage Advance folks in Eugene Oregon. Index of HP1 through HP11 is in issue #11. There is an index in this issue for HP12 through HP17. The back issues are disappearing fast. We are moving ahead with new info. If there is enough interest, we will collect the information in all back issues by subject and publish it as a book sans advertising. RP

PV Rating Clarification

Dear Richard and Home Power Readers: From time to time Home Power articles mention that particular modules put out more than the manufacturer's rating. These statements may be confusing PV users and some clarification is needed. The power output of a module is determined by many variables including intensity of sunlight, atmospheric clarity, ambient temperature and wind. To measure a single parameter such as output current may lead to the conclusion that one manufacturer's product frequently exceeds it's rated output.

The engineers at the Southwest Region Experiment Station have tested well over 300,000 PV modules in the last ten years as systems were tested all over the country and overseas. In FEW CASES have we found PV modules that have even met, let alone exceeded the manufacturer's rating, particularly when installed in systems. Why the difference between tests and Home Power reader experience?

Modules are rated by POWER output at a specific set of standard conditions which are generally a cell temperature of 25° Celsius and an irradiance value of 1000 Watts per square meter. Unless these two parameters are measured and used to convert the actual measured power output back to standard conditions, a comparison of power output is not possible.

For example, a commonly available PV module may be rated by the manufacturer at 48 Watts at 16.7 volts and 2.88 amps when the cell temperature is 25°C and the irradiance is 1000 Watts per square meter. If the irradiance drops to 800 Watts per square meter at a 25°C cell temperature, the maximum power output drops to about 38.4 Watts at about 16.5 volts and 2.33 amps. Without knowing how much sunshine we have, we cannot know what the module is supposed to produce.

Although the module is rated at 25°C cell temperature, most modules operate at cell temperatures in the 40-55°C range. With a 50°C cell temperature, the above module would be able to generate about 2.90 amps at 14.8 volts or about 43 Watts.

Again, unless we can measure cell temperature, we really do not know how the module output compares with its rated value. It is not too meaningful to just measure current output without doing the same for voltage and then converting the resulting power back to standard conditions.

Power output (the product of voltage and current) is generally directly related to irradiance. Current increases almost directly with increases in irradiance while voltage goes up at a much lower rate. Current increases as temperature increases, but voltage decreases at a faster rate, so power goes down as temperature increases. Each module has slightly different characteristics.

When the module is installed in a system, we have power losses in the wire, diode, switches, and fuses or circuit breakers. If the system output is measured and module output calculated from that measurement, we must consider those losses which may be as high as 9% when average module soiling is included. In a system where modules are connected in series and parallel to achieve higher output, a mismatch factor comes into play that may reduce the power output another 5%.

In stand-alone systems that charge batteries, most modules deliver somewhat less than their rated output. Using the example module above, the manufacturer's rating is 48 Watts at standard conditions. The module will operate at 50°C on a summer day which reduces the output at the module to only 43 Watts. If batteries are being charged at about 14.5 volts, the module can deliver only about 41 Watts. In an average system, mismatch and wiring losses may account for another 5% reducing the power rating per module at the PV disconnect switch to 39 Watts. When module output is being stated for an actual system, all of these factors must be considered.

Sincerely, John Wiles, Project Manager, Southwest Technology Development Institute, Las Cruces, NM

Thanks John, We've been thinking that maybe the best way to rate modules is by current (Amperes). The Wattage figures are skewed by voltage measurements (P=IE) that are constantly changing with battery state of charge, battery temperature, PV cell temperature, and system loading. PVs seem to behave, within broad limits, like constant current sources. The amount of current is tied to many factors, the foremost is solar insolation. Factoring voltage into the rating makes it vaguer and more nonspecific since voltage is nonlinear in both batteries and PV cells.

I have no doubt that many of our readers have solar sites that have more solar insolation than the standard of 100 mW./cm.2. This accounts for much of the overspec measurements. But these measurements are real and do represent power produced. During a clear cold (<20°F.) winter day, with snow all around, we've measured a sustained (>1 hrs.) 33.8 Amps into a battery (14+ VDC) from 8 modules rated at 2.89 Amps each. This is 1.3 Amps more per panel than spec (or 46%). While this doesn't mean that these panels are any better than any others, it does mean we had much higher than normal insolation coupled with low temperatures. It all adds up to more power and that's what it's all about. RP

Noooo....Body Knows!!

About a year ago I wrote a letter that was printed in "Home Power" asking for reader information from those who had "China Diesel" generators. There were about 6 responses besides those that appeared in "Home Power" magazine.

Alas, the variety of the responses leaves one wondering what really is happening out there. The responses varied from one person who suggested that the smaller engines be used as anchors for rowboats, and the other extreme from another person who had nothing but praise. If any generality could be made, it may be that the 13hp or larger engines have a better track record. Personally I have a 13hp, 8000 watt unit, and have written a couple of letters to the "China Diesel" company asking for parts, and have never received a response. So, pay your money and take your choice.

Mark Riener, Mount Shasta, CA

A Recycled Paper Fund

Here's my $ for a subscription plus a little for a "Recycled paper fund"! So it costs more... this mag is a bargain at twice the price. If this group of subscribers can't bear the cost, who can we expect to. Increase the demand and the cost will go down. We can't afford NOT to use recycled products.

Jim Sluyter, Bear Lake, MI

We are chasing the elusive recycled paper full time. We will move to it as soon as we can afford it. Right now it's running about four times the cost of what we're using (it comes in giant rolls for a web press as bigger than our house). The paper we use now is recyclable. How about it HP readers, if we went to recycled paper would you help pay the cost increase? RP & KP

A Nerd's Answer

Fellow Travelers, I just received the latest issue today and I am almost through it already. I loved the article on education. The kids are the ones who are really going to need this knowledge.

Unless I missed it in my first rush through, (I usually read each issue at least twice), the person who wrote the Nerd's was not identified. He raises a point that is annoying to many computer users though. I use one at work for large volume jobs and losing a page once in a while on large batch jobs is not a problem. I also have a setup at home and do most of my personal correspondence on it. Since most of this is one page at a time stuff, losing a full page each time I print a page is very wasteful.

The printer I have now has solved the problem permanently but what I used to do was to save a couple of empty sheets of the heavy paper that blank labels come on and cut them up the middle between the tractor holes. When I printed a letter and ran the paper ahead to tear it off, I would simply attach the strips to the end of the paper still in the machine, overlapping the top by a few inches, with Scotch tape or the adhesive edge of Post-Its or whatever else was handy. After a few mishaps I learned to only tape the strips to the part of the paper that would be torn off with the tractor holes at the top corners of the page and the bottom corners of the strips so as not to damage the letter when removing the Scotch tape. This only takes a few seconds and then I would run the paper back into the printer where it would be ready for my next letter with no waste.

Keep up the good work. Health and Happiness, Rev. Joseph Christie, New York, NY

Thanks for the tip, Joseph. I get credit for leaving Bob-O Schultze's name out of the Nerd's Corner article. RP

Q&A on Battery Voltages

Reading your fine magazine has brought a couple of ideas to my mind that I haven't seen discussed.

We are in the process of building a house that will use PVs for electricity. We expect to use about 4 kW per day. The house will be wired entirely for 110 vac, except possibly the Sunfrost refrigerator. We already have 28 @ M-51 ARCO panels (2.31 amps-17.3 VDC). It seems with these panels wired series parallel, a voltage controller and 18 NICAD cells (18 x 1.65 max. voltage=29.70 VDC) one could use a 24 VDC inverter and refrigerator or with the panels, no controller and 21 NICAD cells one could use a 32 VDC inverter, a 110 vac refrigerator and make maximum use of the high voltage panels. I would appreciate it if you could let me know about the practicability of these ideas. Or if we would be better off with the more common combinations.

Thanks, Larry Thompson, Boonville, CA

Hi Larry, the most popular nicad configuration for 24 Volt systems is twenty series cells. This increases the battery's utility under nightly loads because its voltage stays higher. A nicad cell is effectively discharged when its voltage reaches 1.1 VDC under discharge. Under charge rates as low as C/30, the nicad cell will reach voltages above 1.6 VDC when totally full. Rest voltage of a full cell, not under either charge or discharge, is about 1.35 VDC.

Under the 21 cell scenario you mentioned, the discharge voltage would be too low at night to operate the 32 Volt inverter. My advice is to use 20 series cells, regulate the array at about 30 VDC and use a 24 Volt inverter. This allows inverter operation until the nicad battery is totally empty. The 18 cell scenario will have voltage too low to run the 24 Volt inverter when there is still about 25% of the power remaining in the battery. RP.

Q&A Fluorescents

In a recent HP data was shown to indicate that wiring a house for 120vac alone was more cost effective than 12VDC & 120 vac. Sounds good but I do not like the disposable style of 120vac electronic PL lamp/ballast combos. I love Janmars new line of PL conversion units....except they use XMFR type ballasts= Great Inefficiency. Their PL-5 unit consumes, by my measurements via a Fluke D800, 14 watts of ac power. This does not include inverter inefficiencies. By contrast, a PL-5 with Sunalex 12VDC electronic ballast consumes a meager 6 watts TOTAL (as its DC). The Janmar units are incredibly versatile with replacement lamps, interchangeable globes/reflectors etc. Standard transformer ballasts also hum on the inverter so that with their inefficiencies I feel they're out of the question. They do make a #213 series which converts a standard edison base to PL and includes the adaptor threads for their various line of globes --Great--just put in an in-line/external ballast with it & presto ! efficiency & practical good looks. But where (who) to get an equivalent to Sunalex's SXE 1001 that operates on 120vac? Use a DC ballast with step down XMFR & diodes to rectify? Still=hum! The Dulux/Philips line are nice & VERY efficient!

Philips SL18R40 uses a 0.1 amp at 120vac ≈12 watts & 800 lumens. The Dulux have no reflectors...(try 'em in a track light) & the smallest of any electronic ballasted 120vac compact fluorescent is a Dulux EL-7 (7 watt). So, I'm asking for HELP!!! Let's get the word out & find a supplier/manufacturer for an ecologically sensitive, non-throw away ballast, efficient electronic ballast, 120vac PL bulb fluorescent conversion unit!!

In a recent comparison article on batteries it was mentioned that the life of lead acid batteries in a float configuration is 15 years (found it!! HP17, pg. 34). I set up my power system around 4 years before (now) it was actually put into deep cycle service. I used it all as set up...12VDC lighting/inverter etc., but being in a travel trailer where ac grid power was available I just used a battery charger and kept the cells floating (≈1 to 2% capacity cycling, max.). My question is-did I use 4 years of my service life then or not? Does the lifetime clock begin as soon as electrolyte is added to the cells, ie. at the manufacturing facility or dealer point? If so, should I stop babying my 4 L-16's and figure their life is 1/3 to 1/4 over already? (Even tho they were just put into service 1 month ago.) Can one get more than 10-15 years out of L-16's with VERY conscience use, or is there a point where the clock is ticking on their life anyway, so you might as well use them (cycle the batteries).

OH, I've written Janmar about their HORRIBLY inefficient PL ballasts & asked about electronic equivalents. Also Sunalex, in hopes they make or will make such a unit.

Thanks for all you do! I appreciate (in advance) the responses to my question, I realize you MUST be incredibly busy. I want to do my house & neighbor's house wiring in 120vac but really want to do it efficiently or will recommend dual voltage systems. It is often frustrating, but worth it being on the leading edge!

Todd Cory, Mt Shasta, CA

Hello Todd. On the lead-acid cell, yes, they begin some of their aging processes the instant electrolyte is added to the cell. The initial float type service you had them under is the least wearing type. The lifetimes given in HP are statistical averages. Your experiences will be different. I would estimate that you have lost very little life from the L-16s because you kept them under float charge. Our particular pack of L-16Ws has been in repeated deep cycle service for over 10 years. Out of their original capacity of 700 Amp-hours about 500 remains. The self- discharge rate has increased noticeably since they were new. But they aren't dead yet & I'm still giving them the best of care (regular equalization), so we'll see just how long they do go. My advice on wiring is do it 120 vac and use an inverter. This offers simplicity and lower cost overall. The only negative point is the magnetic fields generated by the 120 vac. I suggest enclosing the inverter in a Faraday cage and using twisted pair wiring inside of metal conduit if this is a problem for you. We are working on information about magnetic fields in our systems and their possible health effects. More on this as soon as the info gets hard. RP

Q&A Refers

Dear Home Power, Here is my check for two years for first class delivery of a FIRST CLASS MAGAZINE. Keep up the good work as I have yet to find another magazine that even come close to yours. I just wish it was monthly.

This question is for Bob McCormick (Homemade Low Voltage DC Refrigeration, HP16, P.48) or any one else that might know.

Has a 12VDC Danfoss compressor & controls ever been installed into a window air-conditioner? If so, what size (BTU rate)? What was the current draw? If not, why not? Won't it work? It sure would be nice to cool the RV down when it is 115° outside.

Thank You, Jim Miller, 4920 E Holly Apt 1, Phoenix, AZ 85008

Q&A NICADS

Dear HP, I love your mag and right now am waiting for the next issue.

I have a question about nicads for RV use. I live in a converted school bus and am worried about the higher voltage voltage of nicads. The big 145 amp alternator has a voltage adjust that might go up to 17 volts, but would that damage anything (start, gages, etc.)?

Second, the power mostly goes to power my "car" stereo which is a 240 watt Carver Amp and tape deck. Would the higher voltage be safe for these?

Thanx for your help as I would like to use nicads because of the endless batteries I have frozen because they weren't fully charged!!

Rob Waghbourne, Crested Butte, CO

OK Rob, simply leave your voltage regulator where it is. The nicads will refill at voltages as low as 1.35 VDC per cell (that's 13.5 Volts for a 10 cell, 12 Volt, pack) it just takes longer. Most vehicles using 12 Volt systems are regulated at between 13.8 and 15 VDC. This is just fine for a 10 series cell nicad pack. In fact, Lon Gillas's boss at Pacific West Supply converted his Mercedes diesel sedan from lead-acid to nicads after it ate three lead-acid batteries in a year. The nicad has been in place over eight months now, no mods to the voltage regulator and no problems. RP

Q&A PV Panel Problem

My site faces south and is relatively free of obstructions. My single solar panel is set at the proper angle for this latitude yet I can't get more than 500 mA. at noon. I suspect the panel but how do I test it? It's 34 watts and was manufactured in Maryland about 5 years ago. I can't remember the name of the maker. I would like to go to a larger array and more batteries. Right now I get 2 days use every three weeks and have to charge with my truck when I desire more.

Also, is microwave a dirty word? I like mine at home and would like to add one at camp but can't find out if they will work off a simple inverter or would you need an inverter with a more sophisticated wave form? I'm talking a .86Kw microwave and a 100 watt inverter. If I go to a larger system will I also need regulation?

Bill Walters, Butler, PA

Here's the scoop, Bill. First check the panel for open circuit voltage. If you're charging a 12 Volt battery, then the panel must have an open circuit voltage of over 17 VDC. Maybe you've got a 9 or a 6 Volt panel… If the open circuit voltage is above 17 VDC and you still aren't getting any amps out (check the wiring, is it good?), then the panel is defective. Possible problems here are broken wiring within the panel or deceased cells.

In order to run a microwave of any size, I recommend a 2,000 Watt inverter or larger. For example, we have an 860 Watt (that's 0.86 kW.) Goldstar model that performs well on our Heliotrope PSTT 2.3kW. inverter. In general, most microwaves will work well on inverters, the only problems reported are in a few electronic timers which go double-time demented on modified sine-wave power. Mechanical timers work fine. RP

Comments and Questions

Dear Home Power, Thank you for putting out such a much needed Magazine. I look forward to each issue. I have some questions and comments that I want to address to you.

First, I can see that you are into your computers. I was wondering if you all knew of any bulletin board systems that are devoted to alternative energy? Second, I have some questions regarding surge protectors. I have been trying to use one ever since a short sent a spike to a tape player and severely damaged it. However, I have had some trouble getting one to last. Is there something about inverter power that these things just can not handle? My third question is about Ni-Cad batteries. Does any one recycle them They sound like a good alternative to lead-acid batteries, but if they are not readily recyclable, I can not consider using them.

I would like to put in a word for low voltage homes. There is a move toward using an inverter to supply all of the electrical needs of an alternative energy home. There are some distinct advantages to this. Most notably, easier wiring. However there are some disadvantages as well. One is that low voltage is inherently safer. Another is that there is no electromagnetic radiation associated with DC current --this type of radiation might prove to be harmful. Furthermore, one must be totally dependent on his inverter. Although these units have grown quite reliable in recent years, there is bound to be a problem sooner or later. When that problem occurs, will there be someone around to fix it quick --there would not be around here. Thus, one could be without power for some time. This is what I have hoped to avoid using solar power.

I also want to reply to Fred D Üensing's letter and S.K.'s response (HP16). I do not think we should discount the governments assistance with alternative energy's development. After all look what it has done for the development of other energy sources (note R. Perez's article of the same issue.) There has been some problems in the past with tax credits, but that does not mean we should not seek further government assistance. (I for one do not like the fact I support others electrical habits with out receiving any support for mine.) Solar energy, or computer technology -- including personal computer technology -- would not be where it is today without direct and indirect support. Note the space program which boosted computer and solar developments. Besides if we can get Uncle Sam into solar, maybe he will forget about nuclear.

Thank You, Chip Upsal, Mt. View, MO

Try Environet (the free Greenpeace BB) at 415-861-6503 (computers). Energy stuff is also available for pay on EcoNet (call 415-923-0900 for humans). On surge protectors: they often are unhappy with the mod-sine waveform of inverters. The SL Waber varieties work great on both Trace and Heliotrope inverters. Get one that is rated far in excess of the power you will use through it. This keeps the transorb filters, metal oxide varistors (MOVs) from freaking out. On nicads: Pacific West Supply will recycle, properly dispose of and/or recondition nicads. See their ad this issue. On EM from inverters: yep, it's there all right and it's also all over the grid. We're working on straight info along with the best research we can dig up on the health effects, ways to measure the EM fields at your location and what to do about it. Big job- we'll get it into print ASAP. On the gov't helping out: well, I think we should accept whatever help it supplies. Just let's not wait for them to do anything. Those of us already using renewables are so far ahead of what officialdom thinks is possible that they can't even see us on a clear day. If government wants to catch up quick, then I for one will do all I can to help them. As for waiting for them to fund a project or rule on the feasibility of a technology, forget it. By the time they actually do anything, we'll be flying around in PV powered heliocopters. RP

Notes from the Ozone

Richard Perez

It's been a while since we had time and space to let HP readers know what has been going on with the magazine and the renewable energy industry in general. So here goes…

Home Power Magazine

You may have noticed that this issue is the largest ever- 68 pages. We're also using a heavier cover stock that allows higher resolution on the cover photo. It is not coated. It is recyclable. We went with the heavier cover to help HP issues survive in the third class mail stream. Another new item on the cover is Home Power's UPC bar code. The Universal Product Code enables newsstands and magazine distributors to keep track of the magazines using a light pen and computer. That's right, copies of Home Power are starting to show up on newsstands around the country. What next?

Thanks to all you subscribers, Home Power Magazine is in solid financial shape. The revenue from subscriptions and advertising have enabled us to expand the magazine and assure its future. We are also able to compensate the people who do the work. And this has become necessary since HP has become a full time job for us.

Home Power is really your magazine. Each and every letter, article, photo, and/or clipping you send us is examined and discussed. The info you see in print is what you have been asking for. For example, the articles on PV wire sizing, the Homebrew shunt regulator, the Glossary, the Index and the soldering article in this issue are direct responses to many reader requests. We are doing our level best to provide you with useful, accurate, and up-to-date material. So, if you don't see what you want, just ask!

Photovoltaics

Let me say that what follows about PVs is my interpretation of current events. Since ARCO Solar sold out to Siemens, the PV industry has been nervous. The major player has left the game. The ARCO Solar sellout was part of a general divestiture of non-oil subsidiaries by ARCO. What happens in the future depends a great deal on what Siemens decides to do with its newly acquired PV output capabilities. Scuttlebutt is that the PV modules to be produced in the old ARCO facilities are bound for Europe.

When the deal went down, Siemens didn't want ARCO's grid intertie systems in California at Carissa Plains (110,000 modules) and Hysperia (20,000 modules), and these are being sold on the open market. What all this means to PV users is lotsa recycled ARCO panels, mostly 16-2000 types from Hysperia. The modules from Carissa Plains are 5 Volt types and were used under concentrating mirrors.

With regards to new models of PV modules, Kyocera is introducing a new module line with increased efficiency and power output. The new Kyocera K51 PV module (LA361K51) has an output power of 51 Watts (3.02 Amperes at 16.9 VDC). These modules use polycrystalline PV cells with an efficiency of 14.2%. Other than a new, flush mounted junction box, the exterior of the modules is the same as Kyocera's J model panels. In light of recent events within PV industry, I would like to point out that Kyocera has no financial ties to the oil industry.

Those installing the new MSX Solarex modules should be sure to check the wiring in the junction box. Both Steve Willey, at Backwoods Solar Electric, and I have received panels that came wired for 6 Volt operation within the junction box. While this is easily fixed with a screwdriver, you must know what is wrong. So if you've installed one of these (ours was a Solarex MSX 56) and it didn't charge your 12 Volt battery, then check the wiring box. Your panel may be wired for 6 Volt operation. A quick check of the panels open circuit voltage will show about 9 VDC if it is wired in 6 Volt mode.

MicroHydro

While the PV fellows are nervous, the hydro makers are staying cool. The small hydro turbine producers are developing new and more efficient models monthly. Don Harris continues to refine the stator design on his already legendary alternator based turbines. Paul Cunningham at Energy Systems and Design is putting his permanent magnet turgos far from the battery using new LCB™ technology. Lil' Otto Hydroworks! has reworked the water chamber to generator shaft seal and have obtained efficiencies as high as 49% from their turbines. Currently research is being done on permanent magnet alternators for small scale hydros.

Batteries

The biggest news in batteries is the new nickel hydride (NiH) type from Sovonics. While still gawd-awfully expensive, prices should come down as they get mass produced. Argonne National Labs just ran a test of the Sovonics NiH cells and their conclusions were much the same ours in HP15. We're also getting feedback from many readers who have converted from lead-acid battery systems to recycled nicads. The word so far has been entirely favorable.

Inverters

The new tiny inverters, particularly the PowerStar, are finding many new homes. Twelve volt DC systems that have been happily performing for years, are now being upgraded with these small inverters. The 120 vac appliance causing this change is usually a sewing machine, small power tool or video/stereo.

Help with your system

I stand ready to help. Talk is cheap (in the case of Home Power Readers, free). If you need help or info, I can be reached at 916-475-3179 from 9 AM to 9 PM west coast time.

First Home Power

"YA DONE GOOD!"

Awards go to:

All the RE Dealers
for turning on the lights at night.

All the Energy Fair Folks Nationwide
for getting up and DOING something!

Kyocera
for making PVs that don't use any oil.

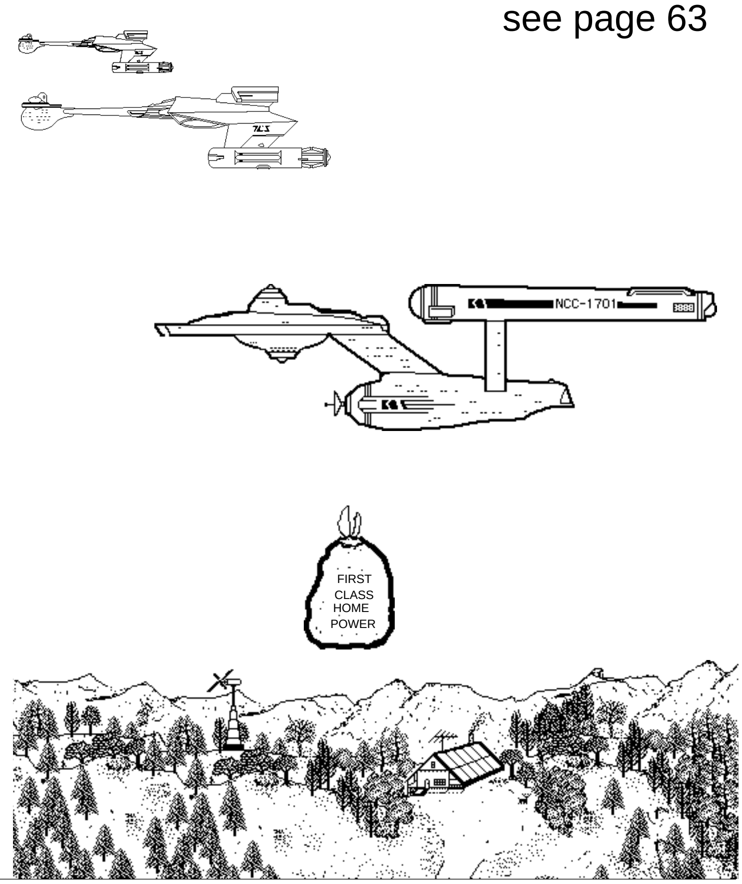
PowerStar
for putting an inverter in our pockets.

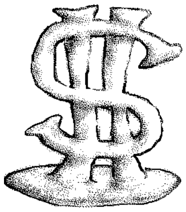
Pacific West Supply
for turning industrial waste into recycled batteries.

Lil' Otto Hydroworks!
for making a turbine from off-the-shelf stuff.

Everyone who produced a renewable watt-hour of electricity. *The future is yours!*

see page 63





Home Power's Business

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

Display Advertising

Full Page	$1,200	67.5 sq. in.
Half Page	$672	33.8 sq. in.
Third Page	$480	22.5 sq. in.
Quarter Page	$377	16.9 sq. in.
Sixth Page	$267	11.3 sq. in.
Eighth Page	$214	8.5 sq. in.

Maximimum Vertical Ad size is 9 inches
Maximum Horizontal Ad size is 7.5 inches

We can set up and lay out your display ad. Camera ready advertising is also accepted. For current, detailed reader demographics, call us.

Long term display advertising is discounted, so buy ahead and save 10% on 3 insertions and 15% on six.

Home Power is published bi-monthly. Ad Deadline for the Oct/Nov 90 issue (HP#19) is 15 September 1990.

Call **916-475-3179** for further details.

International Subscriptions

Due to the high cost of international mailing & packaging, we must charge more for copies of Home Power that are mailed anywhere that doesn't have a US ZIP CODE.

1 YEAR- 6 ISSUES
INTERNATIONAL RATES:

Canada: $12. Can. Contact Northern Alternative Power Systems, POB 14, Pink Mountain, BC V0C 2B0
Mexico: Air- $14. Surface: $12.
Central America, Bahamas, Bermuda, Columbia and Venezuela: Air- $18. Surface: $ 12.
South America (except Columbia and Venezuela), Europe, North Africa: Air- $22. Surface- $12.
Asia, Australia, New Zealand, Pacific Ocean Islands, Africa (other than North Africa), Indian Ocean Islands, & the Middle East- Air $26. Surface $12.

All payments in US currency ONLY!

Surface shipping may take up to 2 months to get to you. All issues shipped in mailing envelopes to withstand the rigors of international mailing. If you have friends with a US Zip code who regularly send you packages, then we can ship them an extra copy for forwarding to you for $6

Mercantile Advertising

One insertion per customer per issue.
We typeset all ads. We do the best we can to make your ad look good. If you send too much copy, then you're bound to be disappointed. Flat Rate $80.
Advance payment only, we don't bill Mercantile Ads.
Your cancelled check is your receipt.

Back Issues

All back issues are $2 each ($3 each outside US), while they last. Shipped in an envelope via First Class US Mail. Issues 2,3,4,6,8,9,10,11,12,13,14,15,16,17 &18 now available. Sorry no more Issues # 1, 5, or 7 are available.
Home Power Magazine
POB 130, Hornbrook, CA 96044

MicroAds

MicroAd rates are 10¢ per character. Characters are letters, numbers, spaces & punctuation marks.
$15. minimum per insertion. Send check with your ad.
We don't bill MicroAds.

Home Power Magazine for Resale

Quantities of Home Power Magazine are now available for resale by newstands, bookstores, energy businesses and others. Please write or call for the specifics.

First Class Home Power

Home Power Magazine (6 issues) via FIRST CLASS US DOMESTIC MAIL for $20. Many of you have asked for faster and more reliable delivery of your issues. So here it is: FIRST CLASS HOME POWER. All First Class issues shipped in an envelope.

Third Class Home Power

Home Power Magazine (6 issues) via THIRD CLASS US DOMESTIC MAIL for $6. NOTE: Third Class mail is not forwardable. If you move, you must let us know. We are not responsible for undelivered Home Power issues sent via Third Class mail.

Home Power MicroAds

Rates: 10¢ per CHARACTER, include spaces & punctuation. $15 minimum per insertion. Please send check with ad. Your cancelled check is your receipt.

INVERTER FOR SALE. Heart model HF12-1200 with 50 Amp battery charger. 12 volts DC in and 1,200 Watts of 120 vac out. Excellent condition. Need bigger inverter. $695. 916-475-3394.

5' X 6' AEROPOWER WINDMILL BLADES, near new to near firewood condition. Harris Hydro Electric, 632 Swanton Rd, Davenport, CA 95017 408-425-7652 or Pick Up at SEER '90 in Willits, August 11 & 12.

JACOBS WIND ELECTRIC replacement parts, new blades, and blade-actuated governors. We make replacement parts and have new blades for most all wind generators, pre-REA to present models. Many used parts, too. Lots of used equipment available: wind generators, towers, both synchronous and stand alone inverters, and Aermotor waterpumpers. Best prices on TRACE inverters. Information: $1; specify interests. Lake Michigan Wind & Sun, 3971 E Bluebird RD., Forestville, WI 54213 Phone 414-837-2267.

PV SYSTEMS CONTROLLER & LOAD CENTERS. Circuit breakers, regulator, & meters all in one enclosure custom made for you. Any size system. Also Solar Electric design & installation services - Wis., Mich. U.P., Minn. Snow-Belt Solar 286 Wilson St., Amherst, WI 54406 (715) 824-3982

FOR SALE HEART H12-1200X, 1200 watt ultra high efficiency inverter. 12VDC input, 120vac output, regulated RNS voltage. Reactive load compatible. Has 50 amp battery charger, standby mode for use as an emergency system. Excellent condition. $700. 916-475-3428

THE LAND NEWSLETTER - Buying, selling, and sharing land with respect. Special opportunities, upcoming events. $10./year or Sample issue $1.00. PO Box 849 Glen Ellen, CA 95442.

HOME POWER CLUB forming in ITHACA, NY. Exchange ideas, experiences, product info, frustrations, etc. Call or write for date and location of first meeting. Chris & Pam, RD1 Box 136A, Berkshire, NY 13736. 607-692-7103 (keep trying)!

LEARN TO TRAP, FARM, DREAM. Five Issues $9. Living Among Nature Daringly Magazine, 4466 Ike Mooney Rd., Silverton, OR 97381 Samples: $2.50.

PORTABLE DOMES AND GREENHOUSES: 20 min. up! Proven performance. Many models. Cat. $1. SHELTER SYSTEMS, PO Box 67-HP, Aptos, CA 95001 (408) 662-2821

1989 GUIDE TO UNUSUAL HOW-TO SOURCES. Describes 50 periodicals & handbooks on backyard tech, camping, crafts, finding new friends, gardening, home education, low-cost shelters, travel, woodslore, etc. All addresses are included. Free for SASE. Light Living Library POB 190-HO, Philomath, OR 97370

HOW TO BUILD THE 5,000 GALLON FERRO-CEMENT WATER TANK that needs no building permit and lasts 7 generations. Complete full sized step by step instructions. $10.00 RIDGEHAVEN, POB 849, Glen Ellen, CA 95442

PURE CASTILE & VEGETARIAN SOAPS. Handmade in an AE environment of the finest ingredients, we have soaps, cremes, bath salts and more. Send for our FREE brochure: SIMMONS HANDCRAFTS 42295AE, Hwy 36, Bridgeville, CA 95526

CEILING FANS,12 VDC, draws only 0.4 amp, 42" diam. oak blades. Send S.A.S.E. to R.C.H., 2173 Rocky Creek Rd, Colville, WA 99114

GEN-PRO 8KW GENERATOR. Propane, electric start, 16hp B/S IC engine, 1 yr. old. Reliable, efficient, powerful. $1200. 603 788-2565

INVERTER SALE Before buying your Trace Inverter, check with us. Our prices are hard to beat. Send S.A.S.E. to R.C.H., 2173 Rocky Creek Rd., Colville, WA 99114.

GREAT 5A. LAND for $5,000.(cash price). Area touted as Solar/ Wind Capital: Colorado's 7,8000' alt. valley. Plenty/Best water (drill 80'± for artesian flow), good access, privacy, loam soil. Fantastic View of 14,000' Mntns. Value climbing fast. Tot. taxes $65/yr. Was for son--No longer have. No gimmicks, No lies--honest bargain. 5 mi. NW from Here-to-Stay owner: Hönn, Windpowered Domehouse, P.O. Box 312, Blanca, CO 81123

THE SOLAR ELECTRIC INDEPENDENT HOME BOOK. 184 8.5" X 11" pages, 50 diagrams, 25 photos. Installation guidelines and schematics, design, maintenance, for super-efficient Photovoltaic systems for independent homes. $15.95 + $2.00 shipping. Fowler Solar Electric Inc., East Coast Mail Order with West Coast Pricing. Box 435, Worthington, MA 01098. 413-238-5974.

SIMPSON VOLTMETER 4" glass face panel meter, 0-15 volts D.C. mirrored linear scale mounted in a 19" steel relay rack box 5 1/4" h. X 4 1/2" d. Includes rugged silver tap switch that can be wired to measure voltage at 6 points in your system. Meter also has 0-150v and 0-300v ranges all internally multiplied and brought out on separate terminals with common negative. $25 + 12lbs. shpg. Marshall, RD3 Box 30-A, Dover-Foxcroft, Maine 04426

SURPLUS SOLAR collectors, liquid, flat-plate, 4' X 8'. $97.50 ea. Get info: Community Builders, 1494 Cedar, Green Bay, WI 54302.

FOR SALE: Storage Batteries, 2V-375, 360 and 270 AH. 48 near new, glass, 131 total $10.00 - $40.00 each. 816-457-3096

240 SCENIC, SECLUDED, ACRES. Good house, trout stream, old blueberry fields, small wind system, diesel backup. DR well, Pos some owner fin. $195,000. E.J. Hess, RR-1 Box 32-D, Deer Hill, ME 04680

UNRESTORED AND NEW OLD WINDCHARGERS: Hebco, Jacobs, Winchargers, Winpower, Paris-Dunn, Ruralite. Props, towers and stubs, 32V motors, control panels, parts, many 6V, cheap. All must sell. SASE please. W. Brawner, 6420 Sloan, KC, KS 66104, 913-334-4486

CHRISTMAS GIFTS, WHOLESALE. Solar Education Kits (Solar Cell, Motor and more) min order 5. 5-10 $4.25 each, 11-59 $4.00 each, 60 or more $3.50 each. Also mini cells and motors. Call Ted at 916-486-4373 Leave message.

BUILD A DEEP WELL 12v PUMP from junk you may already have or easily obtainable parts. Plans $5.00, send to A. Nicholson, 13393 Concow Rd, Oroville, CA 95965

SOLAR FOR SALE: 12 Arco M-53 on Zomeworks tracker $3100. Vanner 24 V 3000 watt inverter, like new $750. Warns submersible 24 V high volume pump $600. Sun Selector control center $500. C. Brumels 3890 Dursum NE Ada, MI 49301 616-874-8899

THE NEW CONCEPT SUNNY SOLAR COOKER rugged, attractive, lightweight, portable, set up in seconds with no bulky reflector flaps, the revolutionary patented metal chamber and reflector module promotes quick and superior heat concentration. Build your own with a professionally illustrated 33 page booklet which includes basics of solar cooking and food preparation. Money-back guarantee. Send $9.95 to SUN, Box (R)630816, Miami, Florida 33163

12V WIND GENERATOR CHARGES AT 72 AMPS $1295. Lots of DC items at SALE prices. New PV modules $65, 30 amp charge controller $69, Amp Hour & Watt Hour Meters, Water Pumps & Motors, Grain Mills, Air Coolers, Low Voltage Water Heater Elements, Electric Vehicles & Parts, Passive Solar Water Heaters, Refrigerators, Lights, Fans, Trace & Vanner Inverters, Waterless Indoor Composting Toilets, Books & Information. Send $3 for catalog. Best products & prices. Kansas Wind Power, R1-HP, Holton, KS 66436 Since 1975

PURE VT MAPLE SYRUP, Gal $35, 1/2 Gal $22, Pt $7, Add $2 West of Miss., Free Recipes, Great for gifts, Full Moon Farm RD1 Box 37 Irasburg, VT 05845

12 VOLT BOXER FAN die-cast metal with brushless D.C. ball bearing motor. 120 C.F.M. on just 6 watts. Starts and runs on 6W P.V. panel. 5 blade rotor is very quiet. 4 11/16" sq. X 1 1/2" d. New. Quantity limited. $25 + shpg. 1lb. Marshall, RD 3 Box 30-A, Dover-Foxcroft, Maine 04426

USED LEAD-ACID STORAGE BATTERIES - 2V, 120 A-Hrs. and 8V - 500 A-Hrs. Good Condition. Bruce Colley 415-686-1788

1500 W 32V AIRLITE WIND GEN. 3 blade 12' Dia. Prop, Blade act. Gov., 48' Tower, system is up & operating but needs restoring. $750/offer. Bob Fisher P.O. BOX 36, Alcova, WY 82620

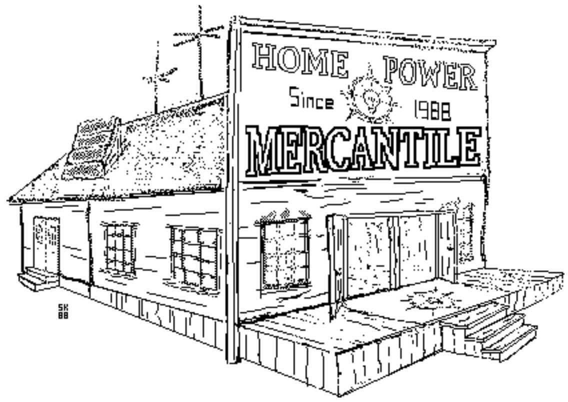
89 ACRES OF ID MOUNTAINSIDE with creek and great view. Fronts on year-round hard-top road, the rear borders on National and State Forests. 24 X 24 cottage and 12 X 16 shop bldg. High head hydro-electric system. Asking $54,000. Gerald Bacon, HCR 60 Box 247, Porthill, ID 83853 or try 208 267 2338

SYSTEM ELECTRIC Offers name-brand PV/Alternative Energy equips at discounts. Call or write for quote/price list. SYSTEM ELECTRIC POB 67 Lyndon VT 05849 (802) 626-5537.

PELTON WATER WHEEL, new bearings. Flywheel belt drive, changeable nozzles, 15+HP. $1200, 8KW 120/240 AC, 1800 RPM gen. $500. Ed Kolz, Montrose, CO 81401, 303-249-5570

5 NEW POWER STAR INVERTERS, ea. $105+ $5 sh. Like new, used 12V record changer turntable, 2 speed w/homemade base, no dustcover-$35+$5 sh. 12V stereo turntables, 2 speed, single play w/ auto return arm & dustcover, no base $40+$5 sh ea. Bill Grice RT2 Box 91-D, Hohenwald, TN 38462

CHINESE ONE CYLINDER DIESEL TRACTORS. $3595. Used extensively in chinese farming. Very economical- all functions. PROTECTED DEALERSHIPS available. CHINA FARM MACHINERY CO. Dept. HP, 23985 Rolling Meadows, Perris, CA 92370, (714) 657-0379



HARRIS HYDROELECTRIC SYSTEMS

High Quality Water Powered Battery Charger
from $595. • Free Sizing Information

632 Swanton Road, Davenport, CA 95017
408-425-7652

Site Evaluations • Installations

INDEPENDENT POWER & LIGHT

PV & Hydro Systems, Winco Generators, NICADs, Sun Frost,
Trace, Kyocera,& Trojan Batteries

RR1, Box 3054, Hyde Park, VT 05655 • 802-888-7194

Sunrise Coffee

True Solar Energy for your Cup!

I custom roast the finest class coffees to the peak of perfection.
Types to choose from: French, Columbian, Kenyen, Sumatra, Guatemalan, Panama, Mexican, Costa Rican, Viennese, Sunset Rose, Fire Mountain and may more.
Five pounds of your choice, roasted the way you want it for $32.50 postpaid.

Sunrise Coffee Company

POB 319, Port Townsend, WA 98368 • 206-385-4117

NEWSLETTER- FREE SAMPLE- 20th YEAR IN EV's

WHATS GOING ON IN YOUR WORLD; CLEAN AIR TRANSPORTATION • TECHNICAL • EDITORAL • DO IT YOURSELF INFO - PLUS--
WORLD ELECTRIC TRANSPORTATION & SOLAR EXPLOSION
Clarence Ellers CE- Member SAE EV Committee
P.O. Box 111, Yachats, OR 97498 • (503) 547-3506

SUNAMP POWER COMPANY Solarex Volume Distributor

Introducing the "BCM" battery capacity meter. Know at a glance the reserve capacity of your battery. Manufacturers of BOS, controls and the world's most reliable regulators- patented, solid state, very low power consumption & they have a 5 year warranty. Send $3.00 for our information packed catalog.

P.O. BOX 6346, SCOTTSDALE, AZ 85261
For technical infromation phone 602-951-0699.
To place an order phone 800-67SOLAR

ELECTRIC GARDEN TRACTORS/MOWERS & ACCESSORIES
COMPLETE PV & WIND SYSTEMS
COMPOSTING TOILETS, SOLAR WATER HEATERS, GRAIN MILLS
Nicad Batteries - DC Motors - Pumps- Wind Instruments - Books - Amp-Hour Meters
New & Used Wind Generators, Parts, Towers, Windmills

best buys **KANSAS WIND POWER** *since 1976*
R1-HP, HOLTON, KS 66436 • 913-364-4407

SOLAR ELECTRICITY TODAY

The best resource guide and directory of suppliers, mail-order catalogs, books, and PV information. Over 600 sources-$7. Formerly PV Network News

2303 Cedros Cricle, Santa Fe, NM 87505
505-473-1067

Index to Advertisers

HOW TO READ YOUR HOME POWER MAILING LABEL

The upper right hand corner of your mailing label contains your subscription type and the number of the last issue in your subscription. For example- "#21". This will be a "#" and a number. # means your subscription type is 3rd Class ($6). The number is the last issue number of your HP subscription.

First class subscribers will find the words "First Class Mail", followed by their last issue number.

If your last issue number is followed by a "G" then some good soul has given you a gift subscription.

If you haven't subscribed yet, then the character "S" will appear and this is your single complimentary issue. Please subscribe now if you want to keep getting Home Power!

HOME POWER MAGAZINE
POB 130
HORNBROOK, CA 96044-0130

Address Correction Requested

BULK RATE
U.S. POSTAGE PAID
PERMIT # 5
HORNBROOK, CA 96044-0130