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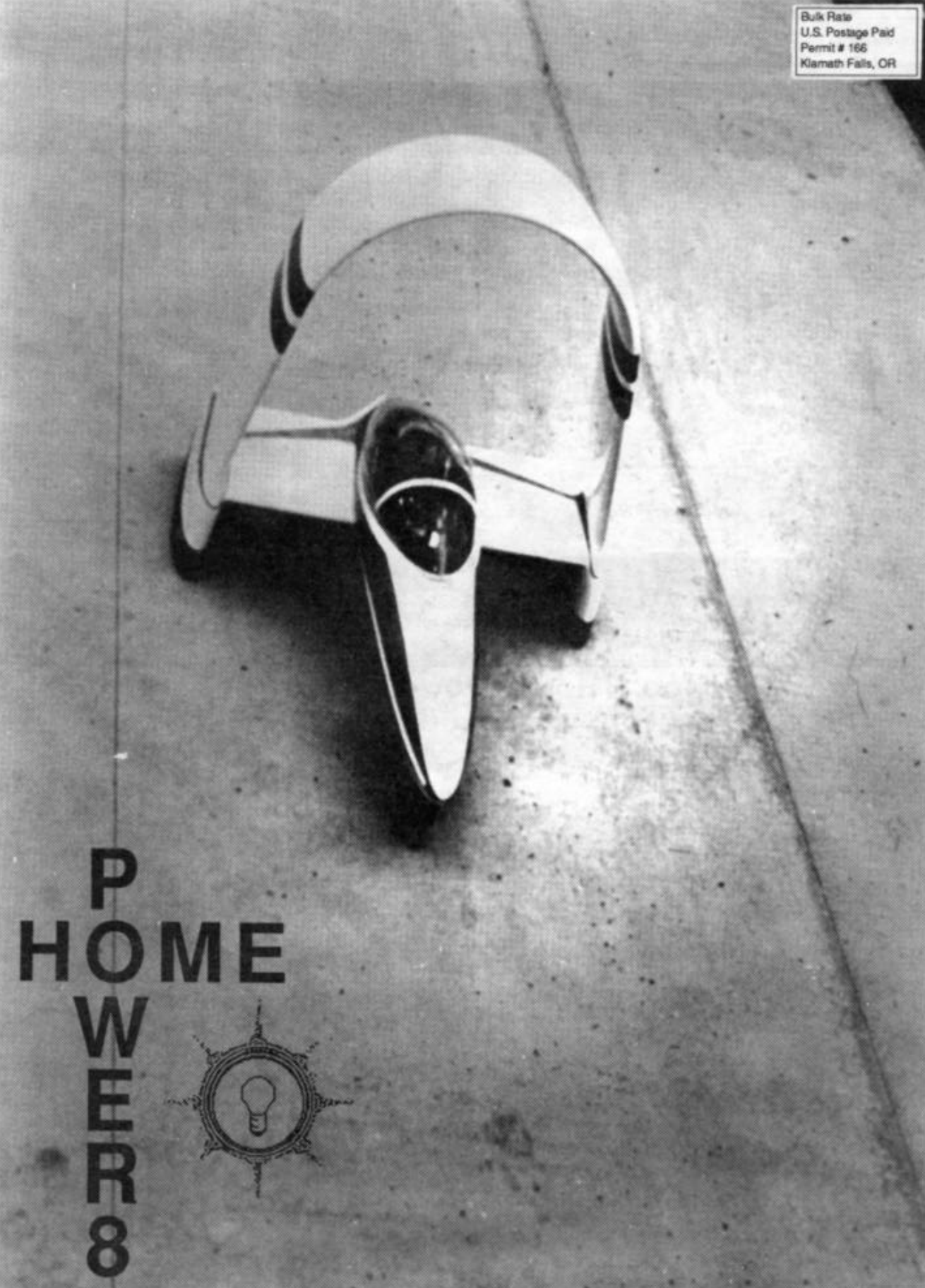

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Think About It

"Truth is great and it's effectiveness endures."

Ptahhotpe - 2350 BC

Cover

The WindMobile- a vehicle powered by the wind!

Photo courtesy of Mike Hackleman & Jim Amick.

Welcome to Home Power #8

The last year has been one of incredible growth for renewable energy. More systems are being installed than ever before. The hardware not only really works, but is cost effective. The word is getting around that RE can provide electricity where the power line can't. Five years ago I figured that a system had to be at least four miles from the grid to make RE cost effective. This distance has now shrunk to about 1/2 mile.

According to SERI (the US Gov't. sponsored Solar Energy Research Institute), the picture for photovoltaics is quite bright. I quote form Sep/Oct 88 SERI publication Science & Technology in Review. "Photovoltaics can supply a major amount of electricity in every region of the U. S. For instance, in the midwest, an area 2.5 miles on a side could displace a typical nuclear power plant (1000 MW peak capacity)." In his editorial in that issue, Jack L. Stone SERI Director says, "Performance improvements coupled with cost reductions and lifetime extensions have paved the way to making PV power a viable electricity generating option for the near future. Recent results in copper indium diselenide and amorphous silicon, for example, show great promise for generating electricity at 12-15 cents per kilowatt hour within the next five years."

The RE scene is blossoming everywhere. R&D promises future marvels at affordable prices. Equipment manufacturers and dealers are reporting higher sales than every before. And us, we're making more power than ever before and we're doing with without damage to our environment.

After a year of publication Home Power Magazine has grown also. This issue goes out under individual mailing labels to over 7,200 folks who have directly requested Home Power. Another 2,000+ copies are distributed to RE businesses all over the World. We are growing at the rate of about 1,000 new subscribers per issue. I wish we had been able to print all the informative articles we had ready for this issue. We simply didn't have space. If our page count increases, then so does the weight of an issue. This kicks us into the next higher Post Office price/weight category and costs us more than we can afford. On the back burner are articles on: large nickel-cadmium batteries, a construction project for electronic rheostats, an article on the technical differences between ac and DC power, this month's Q&A column, and several very interesting System Sagas. We try to respond to what you the readers tell us on the Subs Forms. We try to supply the info **you** want. As such there are 5 Things that Work! reports in this issue, and more info on hydro power.

A note on Things that Work! (TtW!) reports. A reader wrote in asking why he never saw a negative TtW! report. Well, we don't do them. There is enough good gear to write about without bad mouthing anyone's product. We follow Thumper Rabbit's advice, "If you can't say something nice about something, then don't say anything at all." The rules for Things that Work! are quite simple:

1) The device must do what its manufacturer says it will.

2) The device must last in actual service in home power systems.

3) The device must offer good value for the money spent on it.

For the record, a Things that Work! report is not solicited by, paid for, or contingent on advertising by the manufacturer of the equipment tested. These reports are as objective as we can make them.

Once again, thanks to all our advertisers, contributors and readers of Home Power. I want to especially thank our readers for supporting the advertisers in Home Power. It's the ad revenue that makes this publication free to you. Your support of our advertisers makes this publication possible. Thanks! *RP*

A Distant Joyful Choir

©Daniel K. Statnekov 1988

Cold winter breathes its hoar frost breath
Across the stubble fields
Where deer eat wind-fall apples
And prepare for lessor meals

The fast cold stream its edge of ice
A brittle piece of glass
Foretells the time when freeze will hold
It still as it runs past

And creakin' limbs of old oak trees
Just swayin' in the breeze
Sing spirit songs that call out loud
While waitin' for new leaves

Warm mem'ry of that first snow fall
The silent quiet kind
Returns to light my inner eye
And sooth the tired mind

Big soft white flakes I recollect
Were magic nothing less
Just driftin' down, so slow it seemed
T'were headed for a rest

And bells were heard from horse-drawn sleighs
Sweet laughter clear and pure
Rang out across the countryside
A cheerful sound for sure

Black boots and mittens, scarves and skates
Mud-room filled up with gear
The tell-tale sign of carefree days
And fun from yesteryear

Long icicles that hung from eaves
Made real dream castle spires
While tall Fir trees bent low with snow
Before men talked with wires

My heart remembers family friends
So many sights and sounds
Thanksgiving day and Christmas eve
All blessings I have found

Those kitchen smells of warm baked goods
And chestnuts on the fire
Is mixed somehow with times gone by
A distant joyful choir.

The Hybrid Electric Vehicle

Michael Hackleman

Transportation consumes 13% of America's energy budget. This relatively small figure easily disguises the difficulties we face in "cleaning up our act" in this one area. It's easy to monitor and control the emissions of one large, centralized power plant. Not so 60,000,000 tailpipes. This is a good time to take a hard look at the way we do transportation. Even a cursory glance suggests that it may be more practical to look hard at alternatives than to perpetuate the current trends. Or, as Jonathan Tennyson puts it, to design solutions rather than fight problems. Fortunately, there are good alternatives, and this article explores some of them.

Every once in a while, I get a glimpse of the future. I'm not sure if it's the future that will be, or simply one that can be. Still, when I look at the vehicles zipping about on roads in this hypothetical future, what I see is elegant designs that are quiet-running and pollution-free. They are sleek forms that look and perform as though they are very light.

Is this a flight of fancy? Hardly. The vehicle I've described is a high-performance, unlimited range, hybrid electric vehicle. And it takes no stretch of the imagination to see it, or believe that it exists, because it's here, right now.

Admittedly, it's a bit scattered. Or, rather, the technology is. You've probably seen some pieces of it yourself. You may have an inkling of it if you saw the cover of Popular Science in November, 1976. Or if you've faithfully followed Tour de Sol (the solar car races in Switzerland) for the past 3 years. Or the 2200-mile, transcontinental race in Australia held in November of 1987. Or if you attended the 1st American Solar Cup (solar-electric) race held in Visalia in mid-September of this year. I am fortunate enough to have seen all of these pieces, and many more. Electric vehicles have fascinated me for years. So much so that, in 1977, I wrote a book on electric vehicles, publishing a 2nd edition in 1980 to describe the emergence of the hybrid EV.

I wrote six books during the 70's, all of them on alternative energy, and with the do-it-yourself'er in mind. Quite frankly, my experience led me to believe that large-scale projects were perpetually mired in red tape, and managed by folks who's vision appeared to go no further than the next paycheck. As scary as "building-my-own" seemed, then, holding my breath and waiting for someone else to do it had lesser appeal. The hybrid EV I designed at that time was possible but, alas, unreachable for the average person. Low-cost, off-the-shelf hardware didn't exist.

A lot has happened since then. What appeared as insurmountable problems back in 1977 have evaporated over time. In the interim, fledgling technologies have sprouted and matured. Today, we lack only the integration of these technologies to evolve viable electric propulsion vehicles.

We have plenty of motivation, too. The planet is feeling the first effects of the greenhouse phenomenon, an event predicted decades ago. We've got to get off the fossil-fuel fix, and we must prevent the adoption of some pretty nasty alternatives (i.e., nuclear power and methanol fuels) if we're going to reverse the tide.

The Dream Machine

A high-performance, unlimited range, hybrid electric vehicle is a surprisingly simple device. A respectable prototype has seven primary features:

1. Start with a lightweight frame. The higher the overall weight, the more power you need to accelerate any vehicle quickly to speed.

2. Provide a streamlined body. Fully 1/2 the propulsive effort of a typical sedan traveling at 55 MPH is consumed in pushing air aside. The more cleanly you move through the air, the less energy it takes to do it at speed.

3. Use two small DC motors attached directly to the powered (rear) wheels. This eliminates the need for a transmission and differential (both of them heavy and inefficient contraptions) and takes advantage of the motors' unique horsepower-RPM characteristics (more on this later).

4. Install cost/effective batteries. These are the basic energy source for the motors. They may be recharged from utility power at night, when the utility company has a reserve of power. As you'll soon see, they may also recharge from onboard charging systems.

5. Incorporate regenerative braking. Activated by the brake pedal, this enables the motors to become generators, converting the vehicle's momentum back into electricity (stored for later use), slowing down the vehicle at the same time. Incidentally, this is considered an onboard charging system!

6. Add a small engine-generator. Looking very much like a small standby-generator, this device is an onboard charging system that gives the vehicle its "unlimited range" characteristic. Since it is fuel-efficient, it permits the use of alternative fuels like alcohol, hydrogen, etc.

7. Add yourself. That's right, climb in. You deserve well-designed transportation that performs well, and is environmentally benign to produce, use, and recycle!

What's Wrong with Engine Technology?

Internal-combustion (IC) engines are a cheap, relatively lightweight way to convert highly-processed fossil fuels into mechanical energy. This technology found its first real niche in aircraft, an industry that expanded enormously as a result of (and, in part, contributed to) World War I. Engines are wonderful for aircraft, standby generators, and utility power plants. However, if you want to observe genuine clumsiness, inefficiency, and a sad-funny configuration that has embarrassed engineers worldwide for three-quarters of a century, put an

The WindMobile made by Jim Amick. This vechile uses the arch as an airfoil to propell the vechile. It is also capable of using batteries and electric motors to augment the wind's power. Sans batteries the vehicle is capable of travelling 5 times the wind's speed. With the additional weight of the batteries, the car is capable of speeds about 3 times that of the wind. The WindMobile has been clocked at over 70 MPH on the Bonneville Salt Flats and has been running since 1976.

engine in a car.

Why? You cannot talk about the power an engine produces without also talking about its speed, or RPM (revolutions per minute). Engine's produce their "rated" POWER at their "rated" RPM. For most engines, that's 6,500-8,000 RPM (to your ears, that's a roaring scream!). They do produce power at RPM lower than their rated RPM, but there's a lot less of it, and it's less efficiently generated. Engines are happiest and most fuel efficient when they maintain both a constant speed (near their rated power) AND a constant load. In a car, this condition exists ONLY at idle, or at 55 MPH on flat terrain with no head wind. At any other time, the engine is fuel INefficient, and much less powerful.

The use of an engine in a car requires the need for two other heavy and inefficient components: the differential and the transmission. Powering just one wheel can be very dangerous. If you have just one power source (an engine), the car must use a differential to distribute power to two wheels. Likewise, without a transmission, a vehicle geared for high speed would stall the engine at low speed-- it is unable to deliver any real power. Conversely, a vehicle geared for low speed would have blown the engine long before you reached 55 MPH. A transmission, then, matches -- manually or automatically -- the ratio of the engine's RPM to that of the vehicle's wheels. There is a wildly varying range of driving speeds -- stopped versus 65 MPH -- in a standard car.

The ineptness of an engine to deliver useable power except in a relatively small range of RPM affects another area: engine size. The situation is so bad that a car's engine must be sized several times too large to ensure a modicum of power at low engine speeds, and to accommodate the occasional need for normal acceleration, high speeds, and hill climbing at even modest speeds. Of course, fuel consumption goes up if you're lugging around extra horsepower for peak power needs, or to compensate for inherent flaws. Inefficiency is tolerable, of course, if the energy source is clean and inexhaustible. In the case of fossil fuels, neither condition is true. Engines, for the task they're assigned in transportation, wastefully consume enormous amounts of fuel. The pollution that results from exploring, extracting, refining, transporting, storing, and using these fuels is well documented. Since oil was initially discovered, the bulk of it has been consumed, and there is no plan of which I'm aware that intends to preserve what remains. In more candid moments, some oil companies admit that gasoline and diesel fuels will not be available at the pumps by the turn of the century.

This lemming-like attribute is all the more perverse when one considers other equally blind trajectories. An issue I have never seen in print is how much oxygen an engine needs to run. The engine in a car doing 55 MPH will, in traveling just 30 miles, consume as much oxygen as 30,000 people breathe in an hour's time. There are only two major oxygen-producers on this planet -- forests and the ocean. Our view of the first as profit and the second as a garbage dump is burning the same candle from multiple ends. Life will not end, as suggested, with either a bang OR a whimper. More likely, it will be a wheezing, gasping chug as the last engine grinds to a halt. No one will be there to answer the important question. Was it for lack of fuel, or lubricating oil, or oxygen?

None of these issues are properties inherent in transportation itself. It's how we're doing it. While IC-engines do act like "atmospheric processors" in their current configuration in vehicles, they can play a more subjugate role in the hybrid EV. First, however, let's explore the characteristics of electric motors.

Electric Propulsion & Vehicles

Electric motors are well suited to transportation because of two primary attributes: their power curve and their voltage/power ratio. Motors have a flat power curve. Thus, motors deliver their rated power over their full range of RPM. Read that again. A motor rated at 10 HP (horsepower) delivers most of that at 50 RPM, and at 500 RPM, and at 5,000 RPM. All of this occurs at its "rated voltage".

Motors have a useful voltage/power relationship. At half the rated voltage, the motor delivers half the HP -- that's 5 HP at 50, 500, and 5,000 RPM. At twice the voltage rating, a motor typically delivers twice the HP -- that's 20 HP at 50, 500, and 5,000 RPM. That's all a bit technical. The implications of these attributes can be translated this way:

1. Motors don't need transmissions. The motor works as well at 5 RPM as it does at 5,000 RPM. A two-speed transmission is handy to handle steep inclines at low speed, but it's not mandatory as it would be for an engine.

2. Motors perform well if they're underpowered or overpowered. This suggests simplified control functions. That is, motor power is controlled by varying the voltage to it. It also means that motors can take some abuse. A 15HP motor will, by increasing the voltage to it, produce 2-4 times its rating (that's 30-60 HP) for short durations. It's ability to channel some hefty energy is just the ticket for occasional peak loads like heavy acceleration, climbing a steep grade, or passing another motorist.

3. Two motors, each rated at 1/2 of the total required vehicle horsepower, can be hooked individually to the wheels they power, eliminating the need for a differential assembly, and giving you a motor to come home on if one becomes inoperative.

4. A small motor replaces a big engine. This involves two parameters: HP rating and physical size. Typically, a 15-HP DC motor replaces a 100 HP engine! Remember, an engine must be built for a peak power need, and to offset inherent, low-RPM performance. An electric motor is rated for continuous performance, and has inherent characteristics that enables it to double or triple this output for short durations. Motors are physically small, too. A 15 HP motor is 1/6 the weight, and 1/20th the size of a 100-HP engine!

5. Motors in vehicles don't require clutches. A clutch is needed with engines to help shift gears in the transmission. No gears, no clutch. Again, a clutch can be useful in an electric vehicle -- as a disconnect for coasting or safety, for a smoother start, and to limit the initial inrush of current to the motor -- but it's genuinely an option.

6. Motors are simple. There's one moving part and, in normal service, only inexpensive brushes need replacement. No carburetors, timing, or valves to adjust. No fuel filters, air cleaners, spark plugs, or points to replace periodically. Engines are hard to pull out and put in, have bushels of parts that can go bad, and cost a small fortune when they do. Engines leak, too, and oil is a magnet for dirt. So, engines burn dirty, work dirty, and smell dirty. On the other hand, motors make for a clean machine.

Why Aren't Electric Vehicles in Widespread Use?

If they're so great, you might wonder, why aren't electric vehicles in widespread use? A good question! The best answer is: they haven't really been able to "show their stuff". Hybrid EVs, like the one I described at the beginning of this article, are very rare. A more common electric vehicle is the "conversion". Like the name implies, this is a car or van that has been modified to use electric propulsion. Typically, a 30 HP, 96-volt motor is bolted into a standard car that's had its engine pulled out (blown up, more likely, and then removed). Everything else that came with the car is still there -- transmission, differential, sometimes even the gas tank is left in place. Lead-acid batteries are added, lots of them, often filling every nook and cranny. Since there's only one energy source for the motor (the battery pack), this configuration is often referred to as the "pure electric".

The end result is a heavy, cumbersome affair, slow to accelerate, limited in both range and speed. Go too fast, and the range is shortened further. Conversely, if you want maximum range, you accelerate slowly and limit your upper speed limit. When the inevitable battery recharge is needed, it takes a good 6-10 hours to accomplish. Every 18-24 months you must replace the batteries. Hope that nothing, minor or major, goes wrong with it. The local automotive service center won't know what your vehicle is, much less how to fix it.

There were tens of thousands of electric vehicles on the roads at the beginning of this century. Many of them could outperform today's "conversions". Why? If you're building an electric vehicle, you "think" light. and slick. If you're building a car for a powerful engine fueled by super-enriched oil (gasoline), weight and aerodynamics are not issues. Today's manufacturers have discovered the merit of putting engines in lightweight, aerodynamic bodies. The formula doesn't work in reverse. Putting a low-power propulsion system in a heavy, non-aerodynamic body is "silly". The loss of engine weight is trivial compared with the tons of batteries you must add to power such a heavy brick . Understandably, the motor is always starved of power. It's penalized in each acceleration with a reduction in range. It's also easy to damage or destroy the complex

electronics needed to control the high electrical loads.

This is not my idea of an electric vehicle. I expect performance from a car -- modest acceleration, freeway speeds, unlimited range. You won't find it in the conversion. In all fairness, even in a lightweight and aerodynamic "environment", the electric motor is still somewhat restricted in performance (without investing in expensive batteries). The range is further, but it's still limited, compared with today's vehicles. Fortunately, BOTH the "conversion" and the "prototype" electric vehicles take a solid leap forward in performance AND range when configured as a "hybrid".

The Hybrid EV

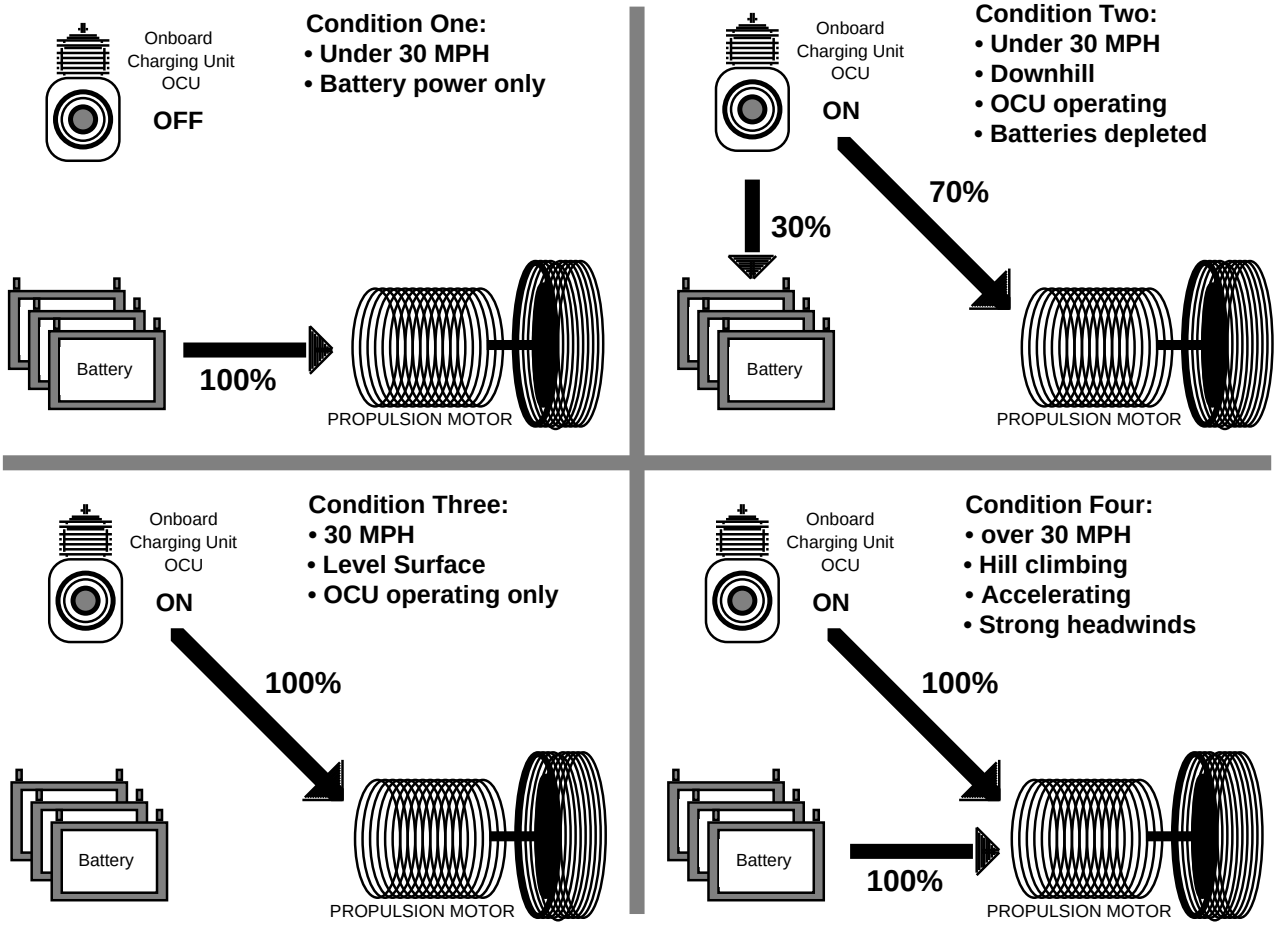
The hybrid EV combines the best features of motors with the best features of engines. The motor contributes its flat HP/RPM and variable-load characteristics, short-term high-power endurance, and its light weight. The engine contributes its high-power density and fuel availability. In the process, each offsets the disadvantages inherent in the other.

The specific configuration is important. The OCU (or Onboard Charger Unit) is a small engine (i.e., 8 HP) coupled directly to an alternator. The alternator's output is connected to the batteries. The powered wheels are connected (through a single gear ratio) to the motor(s). Motor power is supplied through a controller, the input of which is tied to the batteries. Note that the engine is NOT coupled to the drivetrain mechanically.

Here's how it works.

Going shopping? You zip down to the store a few miles away on battery power alone, using energy you stored from utility power, a solar array, or your small hydropower setup. After a few stops, you head home, and plug the vehicle into its charging station. A bit later, you get a call from a stranded spouse. More distance is involved, so light off the OCU. It hums along producing steady, consistent power. When you're stopped at the light or stop sign, all of the OCU's power is going into the batteries. When you're traveling at 15 MPH, some of the OCU's power goes to the motors, & the remainder goes into the battery pack. At some speed, say 35 MPH, all of the OCU's output goes into the motors. At 50 MPH, the batteries supply the additional power (above the OCU's output) needed to reach and hold that speed. More generally, in this vehicle, anytime you go below 35 MPH, OCU power is diverted into the batteries. Anytime you go above 35 MPH, the batteries supply the difference. If you stop the OCU, the batteries take up the full propulsive load.

Here are a few relevant observations:



1. Wheel RPM (and vehicle speed) functions independently of the OCU engine's RPM. The electric motor keeps pace with the wheel RPM.

2. Each electricity source -- batteries and OCU -- operates independently of the other. You can drive on battery power alone, or the OCU alone (at some modest speed, like 35 MPH). Like any good partnership, both the batteries and OCU work together well, or independently of each other.

3. The engine is relieved of the task of producing PROPULSION and assigned the task of producing POWER toward the propulsive effort, battery storage, or both. Thus, when the OCU is operational, the power it produces is never wasted. It's used or stored. Compare that to an IC-engined car stuck in a traffic jam or waiting for a signal light!

4. The OCU gives the hybrid EV "unlimited range". As long as you add fuel, you can operate the vehicle. When higher speeds are used, the battery pack will eventually be depleted. At this point, you may continue at a reduced rate of speed (equal to OCU output alone) or stop for a while, enabling the OCU's output to recharge the battery pack before continuing on at a higher rate of speed.

5. The OCU's engine should have a long service life. Constant load/speed operation of an engine promotes equal wearing of parts, ensuring the greatest engine longevity for the number of hours it's operated.

6. The OCU's engine is less complex than the one used in an IC-engined car. The OCU's engine is smaller, uses a simpler carburetor (a wonderful byproduct of the constant load/speed setup), and has fewer parts. There's less to adjust and go wrong, less expensive parts, and minimal labor for repair or overhaul. There's a lot less heat to deal with, too.

7. Operation in colder climes is made both feasible and comfortable. The OCU's air-cooled engine cannot freeze and crack. With some forethought, the heat it does generate can be routed to provide compartment heating (a real problem with pure EVs). As well, an early lightoff of the OCU in cold weather will warm the battery pack (charging full batteries produces heat), ensuring their optimum performance in operation (a must for lead-acid batteries).

8. An OCU-configured engine is less polluting. Since it is so small and operates efficiently all the time, the OCU engine needs minimal or no pollution-control devices. Furthermore, since pollution-control devices actually contribute to an engine's inefficiency, their absence further reduces exhaust pollutants.

9. More "miles per gallon" has an interesting converse: "less gallons per mile". By decreasing the amount of fuel needed to go the same distance, the hybrid EV design makes it immediately cost-effective to use alternative fuels -- i.e., alcohol, hydrogen, etc. This aligns itself better with the output one might expect in a small-scale alcohol production facility centered on a small farm or in small communities.

10. A hybrid EV makes lead-acid batteries a feasible choice for the battery pack. Lead-acid batteries have low power density and low efficiency compared with other battery types. However, they're inexpensive, readily available, and have a recycled industry behind them. The hybrid configuration offsets inherent lead-acid battery deficiencies in several ways: a. It minimizes the NUMBER and DEPTH of charge/discharge cycles the batteries must endure. This increases battery longevity, permits the use of batteries that cannot survive deep discharge, and limits the exposure of the battery to the effects of sulfation. b. It relieves the battery of the need to store a large amount of power at one sitting, and to ladle it out over the range of the vehicle in operation. The OCU should handle the brunt of the propulsive effort, while the batteries dish out or absorb energy as needed. In this configuration, then, the battery pack acts more as an "accumulator" than as a power source.

11. The OCU doubles as a mobile power source -- for use at or away from the homesite. For a small cabin or homesite, it can BE your power source. Or the OCU can charge your cabin's battery pack.

Owning a Hybrid Electric Vehicle
There's four ways to own a hybrid EV, like the one this article describes: buy one, convert an IC-engined vehicle, convert an electric vehicle, or prototype your one yourself.

Buying a hybrid EV
Where can you get a high-performance, unlimited range hybrid electric vehicle? I can't tell you. I know of no current source for one.

Jonathan Tennyson's group (based on the big island of Hawaii) is working on a production commuter prototype that uses solar-generated electricity instead of an OCU. James Worden, the main person behind the MIT solar-electric car (and winner of the solar-car race in Visalia this past September), plans to do the same thing. My own design (battery, OCU, solar, and regenerative braking) is in a prototyping stage. All of us figure on limited production in 2-3 years, and full production in 5-6 years. My own scheme involves plans and kits for DIY'ers (Do-It-Yourself) following the prototype stage.

No doubt, there's lots of folks out there, puttering away in old garages, fittin' this to that, working out similar schemes. Some folks, of course, keep matters like this a big secret, and you never hear a word until they're ready.

Convert an IC-engined Vehicle
You have the option of converting an existing IC-engined vehicle to electric propulsion, hybrid-configured or not. If you're sharp, good with your mind and hands, familiar with tools, have the shop and space, the time and patience, the money and fortitude, savvy about mechanics and electrics, you can do it. If you're shy on any of these, maybe you know someone who can fill in the missing pieces. Or do it all for you. Any vehicle you convert is already compromised in the areas of weight and aerodynamics, so start light and sleek.

Paul Shipps, a longtime EV designer and builder, has published detailed plans for converting many types of vehicles to pure (battery-only) electric propulsion. Plans exist for the VW Beetle and Rabbit, Chevette, Datsun B-210, Pinto, Fiat 128, Honda Civic, and a few others. Paul also manufactured and sold adaptor plates for mating the stock 20-HP GE motor to the clutch housings in these vehicles. If you own or have access to one of these vehicles, this is an excellent start. If you'd rather convert a Fiero, Triumph, or other car, his book, EV Engineering GuideBook, will be a big help! His dedication, experience, and plain good sense, coupled with career work in aerospace structural design, is a solid asset. His publications puts all the relevant issues on the table, and he's got maddening detail to back it up. (See Sources and References, below.)

Convert an Electric Vehicle
There are many electric vehicles on the road today -- disguised as regular cars -- that will readily adapt to the hybrid configuration. These falls into two classes: industry-converted or home-converted. The EAA (Electric Auto Association; see Sources and References, below) is comprised of people who own, are building, have built, or dream of building their own EVs, and this is a good source of information, components (motors, controllers, etc.), and electric vehicles. Look for a chapter in your area, subscribe to their newsletter, find out when they're meeting (or rallying) in your area, and treat yourself. You'll see both homebuilt and industry-converted vehicles. Go for a ride, mingle with the crowd, learn the language, try not to salivate too much. This experience can turn you On or turn you Off, depending on your expectations.

Modification of an electric vehicle to the hybrid configuration requires a careful analysis of what is possible, what you want, and what exists -- and how to bring the this trilogy to fruition. A clue: Basically, you're adding a standby generator, removing 1/3 to 1/2 of the vehicle's existing battery pack, and making some tough choices about the motor control system. See Sources and References, below.

Prototype your own Hybrid EV
Prototyping your own is a devilish temptation. Why? The propulsive requirements of a high-performance, lightweight, aerodynamic hybrid EV are absurdly LOW. We're talking about 2 to 4 HP for the drivetrain, a 3000-watt engine-generator, and a 72-volt, 100 AH battery pack!

Of course, you must build an elegant environment for such a small powerplant, and that's not easy. If you want to succeed AND survive the experience, you must be real hungry. And possess:

1. The ability to define the relationship between any two of the following factors: performance, aesthetics, safety, acceleration, speed, hill climbing ability, range, environmentally-benign technologies, recycling, maneuverability, crashworthiness, aerodynamics, lightweightedness, cost/benefit ratios, and prototype development standards.

2. Knowledge of what sub-assemblies are lightweight or otherwise useful to your vehicle, i.e., Pinto or Baha Buggy steering/brake/suspension systems; shaft-driven, motorcycle rear ends; aircraft generators for propulsive motors; etc.

3. A smattering of knowledge about batteries, motors, control systems, engines, generators, alternators, steering, suspension, brake systems, fiberglass construction, electricity, and electronics.

4. Demonstrated skills in drafting, design, fiberglassing, survival, diaper-changing, massage, reflexology, and singing before hostile crowds.

It helps to feel okay about being a half bubble shy of level, and having lots of friends that fit that description. If you don't have disposable income and a dedicated space, you get creative. What's creative? A strong ability to mesmerize curious skeptics and convert them into workers willing to perform menial, dirty tasks for long hours at no pay while retaining the feeling of how lucky they are to be working with you. The Huckleberry touch. Note: I am finishing a 2nd article that addresses issues of prototyping your own in extensive detail. If prototyping intrigues you, there's more on this topic in the next issue!

Last Thoughts
The hybrid electric propulsive system is new to vehicles, but it's

not a new concept. Actually, it was successfully demonstrated during World War II in the American submarine! Testament to its success there is the current use of hybrid technology (without the batteries) in the diesel-electric locomotive, the mainstay of our railroad system.

In essence, this says that the technology is, indeed, really here. If you found all of this interesting, but you really need to go wash those dishes, hey, I appreciate the time you took. If you find yourself a bit hungry for more, here's some possibilities:

1. Start reading. Electric Vehicles: Design and Build Your Own appears to be the only book in print on EVs. It has been out for a long time, so it's likely to be in your library. Check it out and read it. If the cover doesn't say Second Edition, you need to order the EV Supplement ($3) from Earthmind (address below); this will supply the chapter that was added to the 2nd edition. If you want your own copy of this book, send $10 to Earthmind, P.O. Box 743, Mariposa, CA 95338.

2. Order EV Sources & References. This publication lists:

a. every book I have in my EV library, and describes what they cover. Most of these pubs are out of print. However, I will indicate their availability. (Note: This publication will be completed by the time you see this article in print. Currently, I am tracking down the publishers/authors of these books, discussing reprinting issues, and obtaining reprinting/publishing rights, if applicable.) At least, it'll give you some titles to run through your local library's computer. At most, I'll loan you a xerox copy of any of them. Inquire about this; you'll need to supply a deposit and pay 2-way postage.

b. catalogs, companies, and other sources for EV-related components, new and used. This will be updated continuously through the EV Networking Newsletter (below). EV Sources & References is $3; see Mailing List, below, for ordering address.

3. Get on my mailing list. Send an SASE (self-addressed, stamped envelope) or send postage money to: Michael Hackleman, POB 1161, Mariposa, CA 95338. Why? Several projects are in progress; among them: a. An EV Networking Newsletter. b. A documentary video on EVs (featuring the Solar Cup race). c. A lending library for EV videos (Tour de Sol, National Geographics coverage of the Australian race, Solar Cup 88, etc). As these firm up, I'll have a way of letting you know -- IF I have your address!

4. Have you designed, built, or owned an electric vehicle? Do you know of someone who has? Please let me know! I want a strong "Letters from Our Readers" section in the EV Networking Newsletter, and source material for feature articles. Please send photos or slides, too. Don't forget a phone number!

5. Ask what you will and say what you want, but please -- don't expect a personal reply. I find it difficult to resist doing this, but the personal toll -- time, energy, etc. -- is a major diversion, and a contributing factor in a burn-out I experienced a few years ago. I am willing to coordinate a newsletter that does widespread networking, disseminates information, and facilitates deployment of EV technology. If your letter isn't answered there, chances are you just need to make better use of the available material, finding the answers to your own questions!

It's been fun writing this. I hope you enjoyed reading it.

Michael Hackleman

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Heart

Zomeworks

Power to the People

Don Harris

In February 1987 we had the opportunity to plan and install a small DC hydroelectric generator on a rural dairy Co-Operative in Nicaragua. The ranch had belonged to a Minister in the Somosa Regime. After the Revolution, the land was distributed to the workers who had formerly lived under conditions resembling serfdom. The Co-Operative has a total of 34 families, 9 of which presently live on site. Our objective was to provide enough user friendly electricity for lights and improvements for present and future families.

The Site

Eight houses are spaced about 75 feet apart in 2 rows of 4 each. The 9th house is over 1/4 mile away and was the original hacienda. It also serves as a gathering place for meals and fiestas. A creek runs within 500 feet of the nearest house and a 3,000 feet long nearly level flume passes between them. The flume was built to feed the swimming pool. It now also provides agricultural water for the dairy operations.

The Project

In November, 1986 I was contacted by some friends who were planning the "Power to the People" project and needed information and hardware. The project was sponsored by Technica, a Berkeley, California based technical assistance organization. They expedited all the complexities of getting to and from Nicaragua. Always one to travel, I joined. Kate, a project organizer, had been at the site previously on a house construction project. From her memory, we had enough site data to build the turbine and collect other necessary parts.

A prime design consideration was to make the system be locally serviceable. This precluded the use of some of the fancier electronic equipment that is so useful to us in the U.S.A. The exception to this was the Enermax charge controller. We had to control battery overcharge and these units are nearly indestructible.

Because of the U.S. embargo, Delco alternators, which we usually use, are very scarce. Japan trades extensively with Nicaragua and the 40 amp Toyota alternator has the proper characteristics. We committed to 12 Volt operation because of the universally available automotive light bulbs, radios, batteries, etc. We chose edison base, 12 Volt, 25 Watt lightbulbs because of their reliability, but took along adaptors to convert to automotive type bayonet base bulbs, just in case.

On February 3rd, four days before I was to board the plane to Managua, I got a frantic message from Kate and Bill. They had driven down thru Mexico and Central America the month before. They had discovered that pipe availability was a problem and we probably couldn't get the 100' of head that we had planned on; perhaps as little as 20! A quick conversion back to a rewound Delco alternator produced a system that would operate from 10' of head up and could use 1 to 4 nozzles.

My plane tickets gave me two weeks in Nicaragua. We had to plan, scavenge parts, transport everything 100 miles, install, troubleshoot and get back to Managua in that very short period of time. Upon touching down in Managua, I was met by Bill, Kate, and Ben Linder, the first American to die at the hand of the Contras.

20' pipe lengths on an 11' truck. Photo by Don Harris

We spent the next 2 days in and around Managua rounding up pipe and hiring a truck to haul the 3,000 feet of 4 inch PVC we managed to obtain. On the 3rd day we headed North to Esteli and the project site.

The original plan was to run a pipe parallel to about 1500 feet of the old flume and then pick up as much head as possible in the creek bed. We set out surveying and found that with our 3,000 feet of pipe we could get almost 100 feet of drop, our original estimate. But we also noted the rugged, almost vertical canyon walls in the gorge and the fact that we had only 9 days left to get it all done. We had the full time help of 2 local people and the whole community at crucial times.

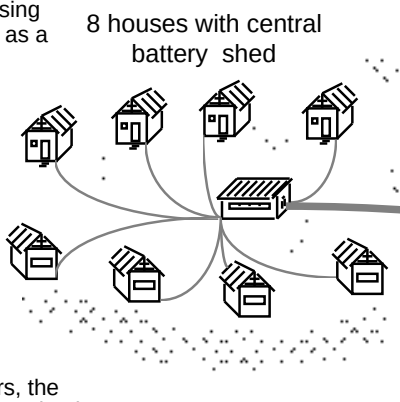
Chris, an American working in Central America, and Ben arrived about this time and an alternative plan emerged: If the flume delivered far more water than the needs of the ranch, we could divert some of the water some of the time thru a 300 foot long pipe back into the creek. This would be much quicker (and thus more likely to be finished) and would save 2,700 feet of very precious pipe for other use. The flume had a diversion gate at about the right place. With a little brick work and some screen as a filter it could be used. Chris and Ben consulted the ranch elders and determined that they could afford 12 hours a day operation in the dry season. We quickly surveyed and found we had 78 feet of head. WE HAD A SYSTEM!

The practical (50% efficient) potential from 300 feet of 4 inch pipe and 78 feet gross head is about 2,100 watts. This would be

using 450 GPM at 54 feet net head. Our unit using 4 nozzles can use up to 160 GPM and could, with the right alternator and at the right voltage, produce 800 watts. Our commitment to 12 Volt operation and our use of the ultra-low head alternator limited us to 8 Amps. This latter limit is due to the small diameter, long wire in the special stator winding.

We had to go 500 feet from the turbine to the batteries and up to 250 feet from the batteries to the houses, a long way for 12 Volt transmission.

We had 3,000 feet of 12-2 Romex wire which translates into 9,000 feet of #12 wire including using the ground wire as a conductor. We did get 200 feet of #10 single strand wire in town, but it is scarce and it seemed almost antisocial to use too much.

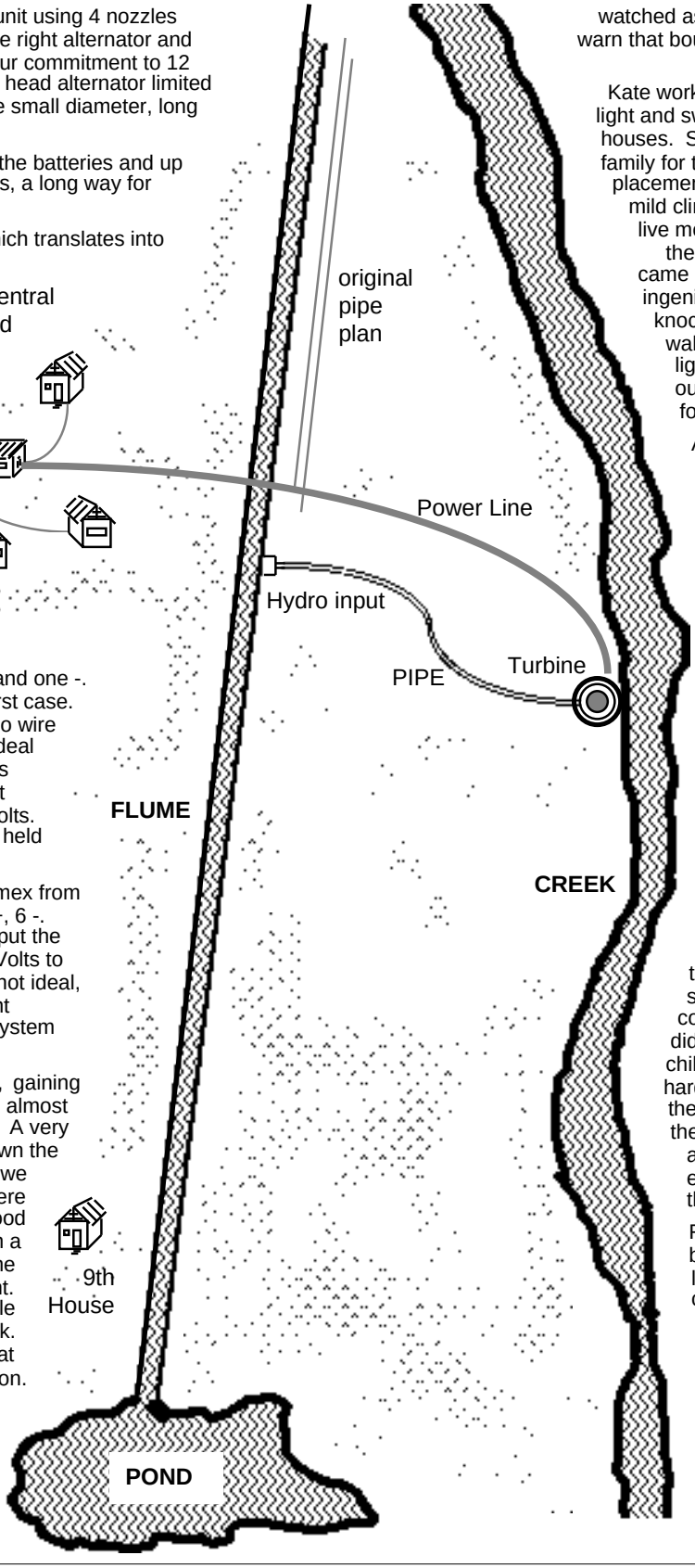


After playing with the numbers, the best choice seemed to be 1 run of Romex to each house, 2 conductors + and one -. This is about .7 Ohm resistance in the worst case. The 25 Watt lights we used are 6 Ohms, so wire losses are a little over 10%. Though not ideal this was acceptable. The practical result is slightly dimmer lights that will probably last longer because they are running at 12.5 volts. The 2-100 Amp-hour gel cell batteries are held at 13.8 volts by the Enermax regulator.

The remaining wire provides 4 runs of Romex from the turbine to the batteries; 6 conductors +, 6 -. This is about .26 Ohms. With 8 Amps output the alternator runs at 16 Volts to deliver 13.8 Volts to the batteries, about 14% line loss. Again not ideal, but acceptable in this case. Any significant increase in power will require raising the system voltage.

The pipe runs almost level for 240 feet, gaining maybe 20 feet head then plunges almost vertically for 60 feet into the creek gorge. A very steep switch back trail goes part way down the canyon, but the last 20 feet are so steep we had to build a ladder to even see if there was a spot to mount the turbine. The wood was milled on site, freehand with a chainsaw. I wish the wood I buy at the lumber yard were all as straight. Fortunately, there was a convenient little flat at a spot about 20 feet above the creek. No one remembered seeing the water that high in the wet season.

We had to tie the pipe to trees to support the weight of the long vertical section and build a sturdy shed roof over the unit because our working resulted in a continual avalanche on the site. Indeed, someone often watched as others worked to warn that boulders were on the way!



Kate worked on building the light and switch wiring for the houses. She surveyed each family for their choice of light placement. Because of the mild climate, most people live more outside than in the house. Someone came up with the ingenious idea of knocking out a high wall board, allowing light both inside and out, and everyone followed.

As our Romex was not direct burial rated, we encased it by dragging it thru 1 inch plastic pipe for protection before burial. This was a most strenuous operation, especially the 4 wire section from the turbine to the batteries.

Each house was individually fused on the + side at the battery end and a protective box was built around the storage/distribution complex. Not only did this protect the children from the hardware, but also the hardware from the pigs, which will aggressively explore anything they can get at.

Finally, one day before we had to leave, the moment came, we turned the valve and the turbine gurgled and belched its way up to 8 Amps in a few minutes. We were on line! Later that day we connected the houses with

PVC glue smells the same in Nicaragua as here…

nary a glitch and the neighborhood lit up!

We had forgotten the 9th, more distant house until the last week. Bill located a battery in town and we set up a shuttle system to the charging station. The following month, Dave Katz of Alternative Energy Engineering went down with solar panels and --- but that's another story.

The final statistics are 125 watts at the turbine using 21 GPM and 77 feet net head. This rather low 40% efficiency is due to high losses in the special wound, low head stator. 110 watts are getting to the batteries after wire losses. The system operating 12 hours will produce 1.3 KWH a day, enough to allow each house 6 hours of light. This far exceeds the perceived needs of the families.

The last day at the ranch was a festive occasion in celebration of the project. We left for Managua with warm feelings and happy memories of this time with our Nicaraguan friends.

What It Cost

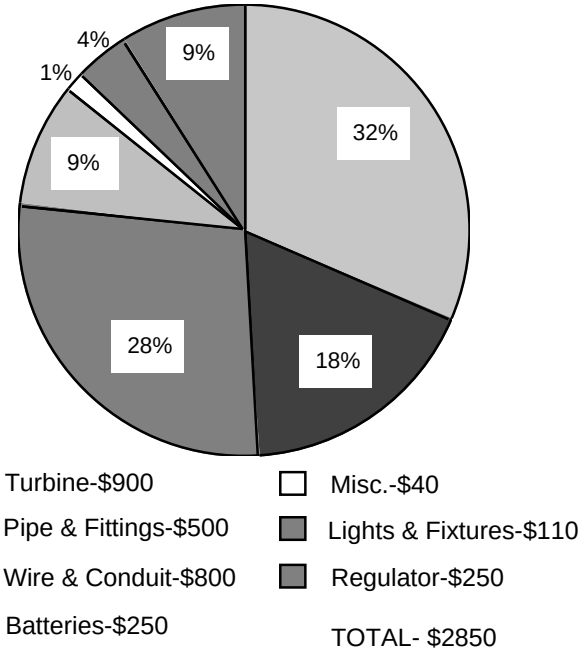
If translated into USA terms, the total hardware cost of the system was $2,850. It breaks down something like this:

The cost per house is $316 including delivered power, house wiring and one set of spare light bulbs and fuses.

Maintenance costs should be primarily battery replacement every 5-7 years, plus occasional light, fuse, and alternator part repairs. The leaves need to be cleaned off the screen periodically and possibly a nozzle unplugged. Time will tell.

Some Final Thoughts

One late night about a week into the project we were awakened by 2 earth shaking explosions. The next day we found that the Contras had blown the main power lines 15 miles from where we slept. These were no firecrackers. Much of Northern Nicaragua was down. When we left for Managua a week later, the only evidence of electricity I saw was at our project. A striking impression was that of hundreds of people hauling drinking water on their backs for miles. The city's water treatment plant is electrically operated. Two facts were evident: 1) the real burden of terrorism is born by the common people, and 2) those of us that produce our own power are free indeed in times of civil strife.



Ben Linder was at the site for two days in the early part of the project. We sat one night and talked about the World. He shared a profound understanding of the situation in Central America. He wanted so much to heal the wounds. We made plans to apply water power to grinding corn and coffee. Ben brought lights and happiness to the people and they loved him. Not only did he electrify several villages, but he helped bring the Children's Circus to Nicaragua. He was the best kind of Ambassador America could possibly have. He is missed there as well as here.

Contributors to the Project

Alternative Energy Engineering, Box 39HP, Redway, CA 95560, 707-923-2277

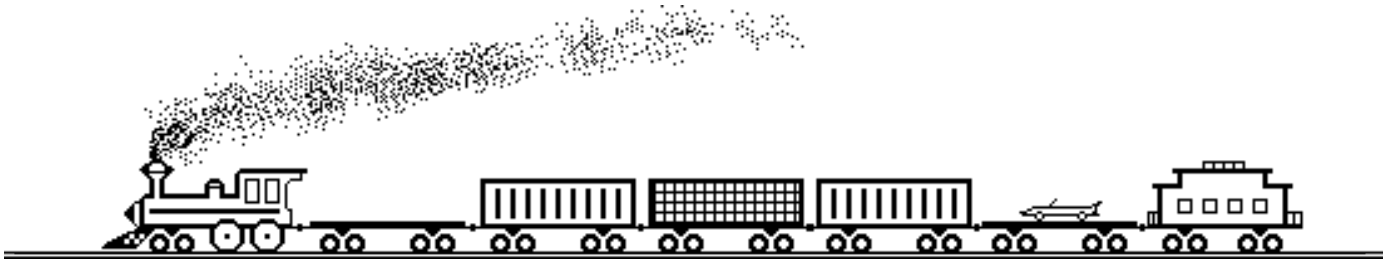
Earth Lab, 358 S Main St, Willits, CA 95490, 707-459-6272

Harris Hydroelectric, 632 Swanton Rd, Davenport, CA 95017, 408-425-7652

Integral Energy Systems, 105 Argall Way, Nevada City, CA 95959, 916-265-8441

AND COUNTLESS GROUPS AND INDIVIDUALS who helped in one way or another.

Celebrating of Day 12.



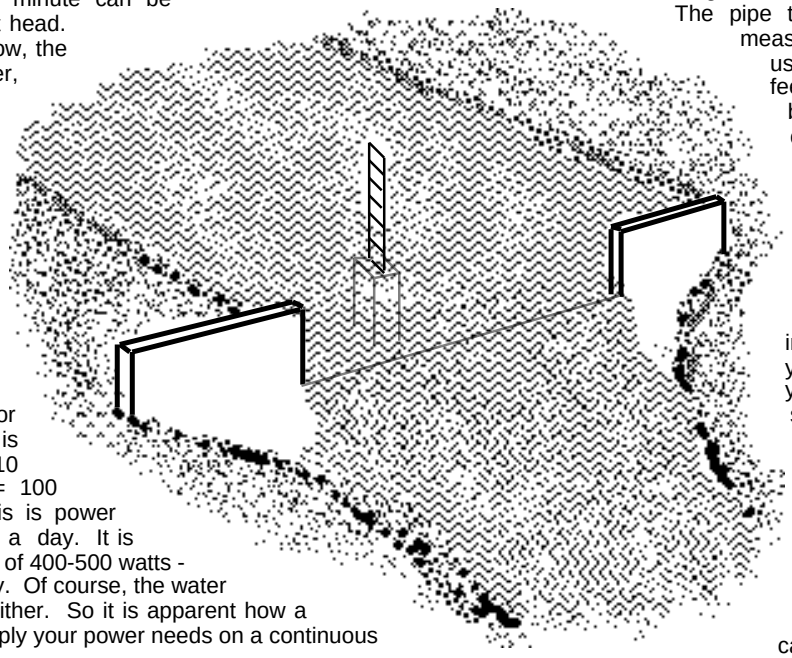
Hydro Siting

Paul Cunningham

Many people have access to some form of running water and are wondering just how much power, if any, can be produced from it. Almost any house site has solar electric potential (photovoltaic). Many sites also have some wind power available. But water power depends on more than the presence of water alone. A lake or well has no power potential. The water must be FLOWING. It also must flow from a high point to a low one and go through an elevation change of at least three or four feet to produce useable power. This is called the head or pressure, usually measured in feet or pounds per square inch (PSI). The flow is measured in gallons per minute (GPM) or for those blessed with larger flows, cubic feet per second (CFS).

At most sites, what is called run of river is the best mode of operation. This means that power is produced at a constant rate according to the amount of water available. Usually the power is generated as electricity and stored in batteries and can be tied to an existing PV or other system. The power can take other forms: shaft power for a saw, pump, grinder, etc.

Both head and flow are necessary to produce power. Even a few gallons per minute can be useful if there is sufficient head. Since power = Head x Flow, the more you have of either, the more power is available. A simple rule of thumb to estimate your power is Head (in feet) x Flow (in gpm) /10 =Power (in Watts). This will give you a rough idea of the power available at the average site and reflects an overall efficiency of 53%. This is a typical output for a well designed system. For example: if your head is 100 feet and the flow is 10 gpm, then 100 x10/10 = 100 watts. Keep in mind this is power that is produced 24 hours a day. It is equivalent to a PV system of 400-500 watts - if the sun shines every day. Of course, the water may not run year round either. So it is apparent how a combined system can supply your power needs on a continuous basis.



Determining Head & Flow

Let's start with the head since that is easier than the flow and will give you confidence to continue. The best method to determine the head is also the easiest and can be used at any site. It is also very accurate. It involves using a length of hose or pipe in the neighborhood of 1/2" diameter. You can start anywhere along the brook and proceed upstream or down. First submerge the upstream end in the water and weigh it down with a rock or something similar. With the top end fixed in place underwater you move the rest of the pipe downstream. When you have reached the end, it is now time to start the water flow through the pipe. This may require you to suck on the end. Once flow is established and all air bubbles are removed, slowly raise the pipe upward until the flow ceases. When this point has been reached, use a tape measure to measure the distance from the end of the pipe to the surface of the water. This reading is the head for the stretch of brook. The pipe then becomes a convenient measure of horizontal run if you use a standard length like 100 feet. If you are working with a brook longer than your length of pipe, then simply carry the pipe to the next section to measure and repeat the procedure as required, starting where you ended before.

It is probably best to "map" more of the brook than you intend to use. This will give you a good overall idea of your site and may reveal some surprises.

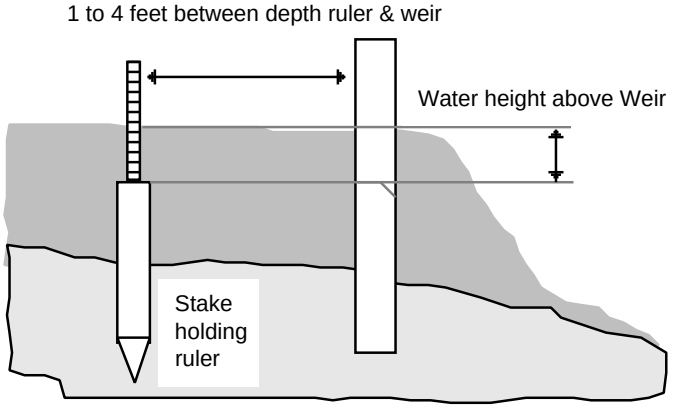
Measuring flow is a little more difficult. This should probably be done in more than one place too. This is because most streams pick up water as they go. Therefore choosing the best spot for your system requires careful consideration of several things.

There are several ways to measure flow; here are two. In both cases, the brook water must all pass through either a pipe or a weir. The weir system uses an opening that the water flows through and measuring the depth of water gives the flow. The first involves a technique very similar to the head measuring technique. You must divert all of the water into a short length of pipe. This will usually require the use of a dam in order to pack dirt around the intake end. Pipe size may be from 1" to 6"

depending on the flow rate. Once that is done the water is directed into a bucket or other container of known volume. The time required to fill it is then noted and this is converted into GPM.

The weir technique is more involved so if the pipe plan works--fine. This consists of setting a bulkhead in the stream with an opening cut in it. The water level is measured as it flows over and with the aid of charts the flow is determined.

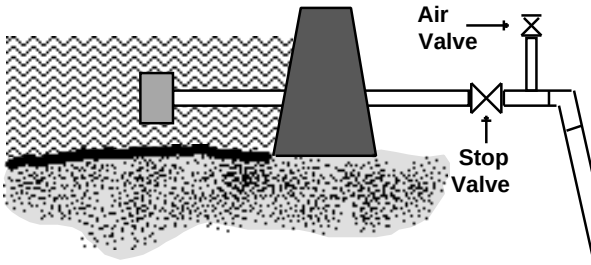
Many materials can be used for the weir but sheet metal is the easiest to make since the thickness is slight. Wood requires a beveled edge for accuracy. A stake is driven into the stream bed a foot or so upstream of the weir and level with the bottom of the notch. This is the point the depth of water is measured since the level drops somewhat at the weir opening.



Water flow should be measured several times during the year.

Weir Measurement Table

Weir Depth	Table shows flow in cubic feet per minute. Width of Weir in inches					
inches	1	2	4	8	12	24
0	0.00	0.00	0.00	0.00	0.	0.
1	0.40	0.80	3.20	25.60	307.	7373.
2	1.13	2.26	9.04	72.32	868.	20828.
3	2.07	4.14	16.56	132.48	1590.	38154.
4	3.20	6.40	25.60	204.80	2458.	58982.
5	4.47	8.94	35.76	286.08	3433.	82391.
6	5.87	11.74	46.96	375.68	4508.	108196.
7	7.40	14.80	59.20	473.60	5683.	136397.
8	9.05	18.10	72.40	579.20	6950.	166810.
9	10.80	21.60	86.40	691.20	8294.	199066.
10	12.64	25.28	101.12	808.96	9708.	232980.
11	14.59	29.18	116.72	933.76	11205.	268923.
12	16.62	33.24	132.96	1063.68	12764.	306340.
13	18.74	37.48	149.92	1199.36	14392.	345416.
14	20.95	41.90	167.60	1340.80	16090.	386150.
15	23.23	46.46	185.84	1486.72	17841.	428175.
16	25.60	51.20	204.80	1638.40	19661.	471859.
17	28.03	56.06	224.24	1793.92	21527.	516649.
18	30.54	61.08	244.32	1954.56	23455.	562913.
19	33.12	66.24	264.96	2119.68	25436.	610468.
20	35.77	71.54	286.16	2289.28	27471.	659313.



Once a month will give a good idea of how much power can be expected year round. The 50% efficiency rule applies to sites with heads greater than 30-40 feet or so. At lower heads everything becomes more difficult. Turbine and pipes become larger and speeds of rotation decrease.

The diameter and length of pipeline can now be determined once you have an idea of the potential power output of your site. It is assumed that you are planning on using a TURBINE and will generate ELECTRICITY. Other courses of action are possible but will not be discussed now.

A rough average of the stream flow can be made after you have made measurements at different times of the year. Most sites will have periods of very high flow that don't last long and times of very low or no flow at all. You need a pipeline capable of handling a reasonable flow average.

Let us use an example of a typical site and see what is involved. Assume your measurements show that 100 feet of head is available over a distance of 1,500 feet. The water will be taken from the high end of the pipe and discharged at the low end through the turbine at a point as close to the brook as is reasonable. This will give you the maximum head available. Exceptions to this will be where the discharge water is to be used for another purpose (aquaculture, irrigation).

Assume for the example that a flow of 30 gpm is available most of the year. Any pipeline will produce maximum power when the pressure drop due to friction is 1/3 of the pressure when no water is flowing. The pressure available under conditions of water flow is called the NET or DYNAMIC head. The pressure under conditions of no flow is the STATIC head. The difference between these two is the loss due to friction. Therefore the larger the pipe the better.

For the example you will require a pipeline that has no more than a head loss of 100/3 or 33.3 feet (over 1,500'). This is 33.3/15 or 2.22 feet of head loss per 100 feet of pipe. Since this flow rate will probably allow the use of fairly small pipe, let's use the chart for polyethylene. Two inch pipe gives a flow loss of .77 feet per 100 feet and 1 1/2 inch gives 2.59. From this information the 1 1/2 inch looks a little small and with the 2 inch we can use up to almost 55 gpm before the power drops off (50gpm = 1.98' head loss and 55gpm = 2.36 feet head loss/100').

So the choice of 2 inch pipe will cause a pressure drop of .77/100 x 1,500 = 11.55' head loss or a NET head of 100 - 11.55 = 88.45 feet at a flow of 30 gpm.

Editor's Note: See pages 25 and 26 of this issue for Poly and PVC Pipe Tables. We put them in the center as a tear out for your wall.

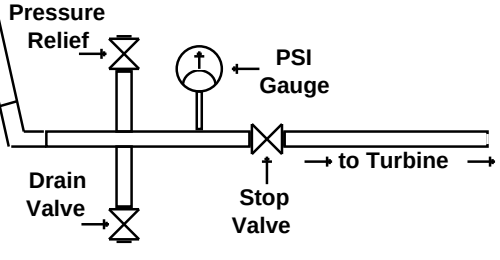
Water must be channeled into the intake end of the pipe. This may require a minimal dam sufficient to raise the water level a foot or so. It is useful to make a small pool off to one side of the main flow for this so that the trash (leaves, twigs, sand) will largely bypass the inlet. The inlet can be covered with window screen and need only be a simple wooden frame to support the screen and have a hole for the pipe to enter.

To facilitate draining the pipe, valves can be fitted as shown. A valve the size of the pipe can be installed just downstream of the intake. This is followed by a small air inlet valve to allow the water to exit and prevent pipe collapse. At the turbine end of the pipe a valve should be installed just before the turbine with a pressure gauge upstream of it. This will enable you to stop the flow and determine the pressure under both static and dynamic conditions. Another valve may be added on a tree to drain the pipe without running the turbine. A pressure relief valve can be added in higher pressure systems. Keep in mind that even if you are always careful to shut the stop valve slowly, the pressure can still rise suddenly for at least two reasons. A piece of trash may plug the nozzle or air pockets may discharge causing the water to speed up and then slow down abruptly when water hits the nozzle. Some respect for the forces involved will help protect your system.

Another area that may require protection is the aquatic environment your system intrudes upon. Remember that your water needs should not cause the stream level to become too low. Many areas also have legal guidelines for the use and diversion of stream water.

The next article will cover turbine types.

Paul Cunningham owns and operates Energy Systems & Design, POB 1157, Sussex, NB, Canada, E0E 1P0, or call 506-433-3151. Paul specializes in microHydro system design and manufacture.



The Copper Cricket Brings Solar Water Heating to Life

Sage Advance manufactures the Copper Cricket geyser pumping solar collector. It has no moving parts, no sensors, no valves, it's freeze proof to -150° F and pumps the heat from the roof to a heat exchanger that sits under the storage tank as much as 36 feet below. Recent SRCC certification shows that the Copper Cricket is one of the most efficient solar water heating systems available."The more complex the system, the more energy required to maintain the complexity". When I returned from vacation a few weeks ago, that was written on the wall of the Sage Advance washroom (one of our most efficient forms of communication). I knew that the author of that graffiti got the message. That's what we're all about. We don't solve problems: we find solutions that avoid problems.

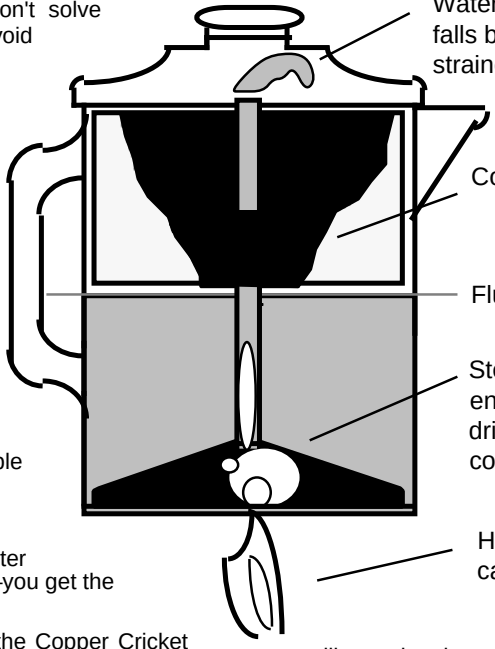
Ask anyone, "what's wrong with solar water heating?". They'll reply, "it's a great idea, but it isn't dependable, it breaks down, it freezes and floods your house, you can't find replacement parts, the pumps burn out, the sensors go out of calibration, the antifreeze needs to be checked every few years, and the systems are too expensive". The typical method for dealing with these problems was to increase the complexity by adding another sensor or a better pump or a secondary freeze controller…We said WHOA! Can you imagine what a bumble bee would look like if it had been engineered like that? Four-inch wings, bigger pollen baskets, extra legs, blunt stingers, infrared sensors, microcomputer blossom-to-blossom route optimizers—you get the picture.

When we began the development of the Copper Cricket technology, we set a few ground rules:

1. **no movings parts**
2. **freeze proof**
3. **no maintenance requirements**
4. **storage tank in the house or basement**

It was like saying we're going to design a bumble bee with tiny wings and a fat body and it's going to have to fly anyway. At almost every turn in the road we ran into a problem that could have been solved by adding something that would have made the system more complex, but we hung on to our rules and searched until the problem could be solved more simply. The result is a solar system with a life span equal to the house that sits under it. The only potential for maintenance is occasional washing of the collector plate glass and flushing of the domestic side of the heat exchanger. The system is easy to install because of the simplicity. The collector is mounted on the roof like any other flat plate except that there is only one roof penetration for the pipes, and it is under the collector, not outside the perimeter of the collector. Therefore, the roof penetration is protected from the elements and no plumbing or insulation is exposed to sunlight or weather. Two insulated 3/4" copper lines run from the collector to the heat exchanger (we suggest one-piece flexible copper pipe for each run). They are soldered into two female connectors on the heat exchanger. After that you just pour in the transfer fluid and draw the air out of the top of the system with a hand held vacuum pump. Installation time can be as little as 4 hours. Early prototype systems have been operating for 3 years, and since June of '87 Production models have been installed all over the U.S.; we even have six operating in the Bahamas.

By now you're probably wondering how the geyser pump makes the hot fluid go down to the heat exchanger. The geyser pump principle is simple: just as heat causes the water in a coffee percolator to boil and rise in a tube to the top of the pot, the Sun powers the geyser pump solar collector to capture and store solar energy.



The antifreeze liquid boils at a predetermined spot in the riser tubes. The boiling action produces vapor which drives liquid above that spot up into the header manifold. Gravity then pulls the hot liquid out of the header manifold and down to the heat exchanger where it gives up its heat to the water in the storage tank. After the liquid gives up its heat it is pushed up to the vapor condenser which transforms the vapor (produced by the boiling solution in the risers) back into a liquid. This liquid then returns to the bottom of the collector panel and re-enters the risers.

The Copper Cricket represents a giant step beyond other solar water heating systems. It isn't a thermosiphon or phase change process (both of which require a large, hard-to-hide, storage tank above the collectors), nor is like a batch system, where the storage tank acts as the collector. It is more like an active system where attractive collectors sit on the roof, the storage tank is down below, and freeze-proof magic transfers the heat from the collectors to the tank.

Copper Cricket domestic water heating systems can be installed for less than $2000 and are still eligible for tax credit in many states. Sage Advance Corp., 4209 W 6th Ave., Ste A, Eugene, OR 97402 or call 503-485-1947.

The Battle of the Currents

J. Michael Mooney

One hundred years ago man stood at the brink of a new era. Electricity held the promise of a more rewarding and productive future for both home and industry.

Edison's 90% efficient dynamo was generating electricity in the U.S. and in England. Edison's electric light and a few electric motors were the only appliances thus far available, with such basics as volt meters and ammeters still on the drawing boards.

A bitter controversy erupted between Thomas Edison and George Westinghouse as to the voltage level and current selection to be used in implementing this newfound technology. The "Battle of the Currents" raged from 1885 to 1893.

Edison firmly believed that voltage levels should remain low (about 40 Volts) to preclude the danger of electrocution, and in the "smooth and continuous power of DC which could be stored in batteries and used as needed." Edison warned that "high tension alternating current was exceedingly dangerous and unmanageable."

Westinghouse had his sights set on large commercial applications, not the least of which was large scale distribution of electricity as a commodity.

At the peak of the Battle to demonstrate the danger, an Edison employee toured the country electrocuting stray dogs with alternating current - "Westinghousing them" he said.

A Serbian engineer, Nikola Tesla, who had come to the U.S. in 1884 and found employment with Edison, opted to join forces with Westinghouse. It was Tesla who began to invent large motors, & later polyphase devices to operate from alternating current.

The massive power available at Niagara Falls, Tesla's ac inventions, and the huge power market at Buffalo, NY, 22 miles away tipped the scales in favor of alternating current. Edison had lost the "Battle of the Currents."

Today, with thousands of people dead from electrocution and hundreds of monopolistic power companies at our throats, we have begun to look back. We have readdressed the 1885 task of designing low voltage DC appliances, refined the 1839 discovery called photovoltaics, and we are moving toward Edison's vision of physical safety and financial independence.

Edison lost the battle, but he is about to win the war.

CONDENSED FROM 1982 ISSUE OF (NOW EXTINCT) SOLAR AGE MAGAZINE

Edison's Rural House

When Thomas A. Edison was asked whether the blessings of electric power could be extended to rural homes unreached by utility, he turned his attention to the problem and came up with an answer like Gen Set Plus.

A demonstration project called The Edison Twentieth Century Suburban Residence was opened to the public in 1912 in Lewellyn Park, New Jersey, with electricity provided from twenty-seven 150 amp/hr batteries kept charged by a 4hp gas engine generator (housed in the stable).

The house must have been a marvel. Sixty-four light fixtures and lamps gave it a degree of illumination rare in those days, even in electrified city homes. The list of appliances is impressive, even by 1982(8) standards: vacuum cleaner, washer, ringer, and iron, refrigerator, stove, broiler, toaster, perk, and teapot, egg-boiler, baby bottle warmer, and hot shave mug. The bedrooms had bed warmers, the billiard room had a movie machine, the living room had a phonograph, and the library had a dictating machine! Chicks were hatched in an incubator-brooder in the stable.

"Edison saw the efficiency and economy of storing power from a part-time source in batteries, and having it available on a full-time basis."

Is There A Gasifier In Your Future?

Art Krenzel

Not all sources of renewable energy are as ethereal as sunlight or the wind. Some are as solid as a tree. Gasification of waste wood offers a renewable energy source for combustion.

Thermal Self-sufficiency

I recently met Richard and Karen Perez and we discussed Renewable Energy Lifestyles. It appears we have been traveling along parallel paths for the past 14 years. While Richard and Karen were concentrating on electricity, my work was and is toward home thermal self sufficiency (i.e. zero supplemental heat). By specifying appropriate insulation, adequate thermal mass and solar gain, most homes can operate the majority of the year without the additional thermal input of heating or air conditioning.

As an example, there is a house located at 7,100 foot elevation in the Rocky Mountains which is super-insulated, passive solar, and semi-underground. If there is a **no** (zero) solar insolation at all during January, they would lose only 0.8°F per day. It is so conservation minded that the heat given off by the occupants is included in the thermal calculations.

Most people would not consider thermal conservation at such an intense level to be a practical investment. Just as there are trade offs in renewable energy equipment, (PV's, batteries, generators, etc.), so there are trade offs in thermal design (solar gain, thermal mass, heating systems, etc.). With the homeowner's input as to their budget, convenience level desired and lifestyle aspirations, a home can be personalized in thermal self-sufficiency as well. The home can utilize locally available biomass energy as well as mixing and matching solar and thermal processes. Thus presenting the homeowner with a variety of energy options.

BioMass- Wood Energy

At the current time, I am promoting further development of a process which makes "producer gas" from waste wood products. The process is called "gasification". Gasification is the partial combustion of wood into gaseous products which can fuel a generator or automobile engine. A similar technology was used by the European countries during during WWII to power their vehicles during gasoline shortage. Producer gas is not the optimum fuel for mobile operations. However, these gases can be compressed and catalyzed into liquid methanol, an alcohol (CH_3OH). The process will convert one ton of dry wood into approximately 150 gallons of storeable liquid fuel. Methanol can be used to power a car, generator, heat your home and used as cooking fuel. Methanol (not to be confused with Ethanol-a vital ingredient in home brewed liquid refreshments) is a storable liquid fuel which can be transported, pumped, delivered and utilized like gasoline. Due to its chemical makeup however, it burns cleaner, at lower combustion temperatures and with lower emissions than gasoline. It is the fuel of choice in the high RPM, high compression ratio engines used at the Indianapolis 500 race. In an engine properly designed for methanol use, approximately 1.3-1.5 gallons of methanol equals a gallon of gasoline.

The gasification process could power a generator engine with the output gases of a gasifier fired with dried wood chips. A gasifier is a small well insulated combustion chamber permitting the very high temperature reduction of wood particles. The gasification process occurs without enough oxygen to burn completely to CO_2 and water vapor. At these operating conditions, carbon monoxide and hydrogen gas are produced with a heating value of 150 BTU per cubic foot.

Producer gas can be used directly in an internal combustion engine. Wood, a renewable resource, becomes the sole energy input to the generator. The engine is derated to 75-77% of its normal output and can follow varying loads as necessary. Waste heat from the exhaust gases can be recovered by a heat exchanger and transferred via heat pipe to a large thermal mass. The thermal mass can stabilize house or greenhouse temperatures. This way the fuel used to generate electricity can also provide the heat to maintain the temperature of a house at no extra cost. A proper balance of house and heat loads with passive solar areas would allow intermittent operation of one wood fired power source supplying the entire daily electrical and heat requirements. I thank *Home Power Magazine* for this opportunity to bring an overview of the gasification project to you. Your comments are invited.

A School for Energy Transitions

In an attempt to foster renewable energy technologies, I propose the beginning of school for energy change . This school could provide an in-residence, educational experience in all forms of renewable energy. The facility would be complete with trained instructors, classrooms, fully equipped shops, organic farm and operating Renewable Energy Systems. It would provide an area where all manufacturers of RE equipment could display their products and demonstrate what it does best. Hands on instruction in your particular type of system along with theory and practical training could be available on a tuition seminar basis. RE equipment could be constructed by students at the school to fit their specific needs. We are currently seeking University affiliation to obtain proper certification for the courses being offered.

In an attempt to determine the interest in such a school among the Home Power readers, we ask you for your input. Would you be interested in attending, teaching in, or supporting such a school? Any ideas on improving the concept would be greatly appreciated as well. Please address your comments or questions on the school or on wood gasification to: Art Krenzel, Transitional Technologies, Inc., POB 117, Greenview, CA 96037 or call 916-468-2349.

Editor's Note: Art is well on the way to perfecting a homestead sized wood gasifier. In areas with significant waste wood (like the US Pacific Northwest), gasification can enable us to better use the renewable resources Mama provides. When the prototype has finished testing, look for a detailed construction article in Home Power. We applaud Art's idea of a school of renewable energy and will participate in the project.RP

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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** _____

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

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Friction Loss- Polyethylene (PE)
SDR-Pressure Rated Pipe
Pressure loss from friction in psi per 100 feet of pipe.

Flow	NOMINAL PIPE DIAMETER IN INCHES							
GPM	0.5	0.75	1	1.25	1.5	2	2.5	3
1	0.49	0.12	0.04	0.01				
2	1.76	0.45	0.14	0.04	0.02			
3	3.73	0.95	0.29	0.08	0.04	0.01		
4	**6.35**	1.62	0.50	0.13	0.06	0.02		
5	9.60	2.44	0.76	0.20	0.09	0.03		
6	13.46	3.43	1.06	0.28	0.13	0.04	0.02	
7	17.91	4.56	1.41	0.37	0.18	0.05	0.02	
8	22.93	**5.84**	1.80	0.47	0.22	0.07	0.03	
9		7.26	2.24	0.59	0.28	0.08	0.03	
10		8.82	2.73	0.72	0.34	0.10	0.04	0.01
12		12.37	**3.82**	1.01	0.48	0.14	0.06	0.02
14		16.46	5.08	1.34	0.63	0.19	0.08	0.03
16			6.51	1.71	0.81	0.24	0.10	0.04
18			8.10	2.13	1.01	0.30	0.13	0.04
20			9.84	2.59	1.22	0.36	0.15	0.05
22			11.74	**3.09**	1.46	0.43	0.18	0.06
24			13.79	3.63	1.72	0.51	0.21	0.07
26			16.00	4.21	1.99	0.59	0.25	0.09
28				4.83	2.28	0.68	0.29	0.10
30				5.49	**2.59**	0.77	0.32	0.11
35				7.31	3.45	1.02	0.43	0.15
40				9.36	4.42	1.31	0.55	0.19
45				11.64	5.50	1.63	0.69	0.24
50				14.14	6.68	**1.98**	0.83	0.29
55					7.97	2.36	0.85	0.35
60					9.36	2.78	1.17	0.41
65					10.36	3.22	1.36	0.47
70					12.46	3.69	**1.56**	0.54
75					14.16	4.20	1.77	0.61
80						4.73	1.99	0.69
85						5.29	2.23	0.77
90						5.88	2.48	0.86
95						6.50	2.74	0.95
100						7.15	3.01	**1.05**
150	**Numbers in Bold indicate**					15.15	6.38	2.22
200	**5 Feet/Second Velocity**						10.87	3.78
300								8.01

Home Power Magazine

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Friction Loss- PVC Class 160 PSI Plastic Pipe

Pressure loss from friction in psi per 100 feet of pipe.

Flow	NOMINAL PIPE DIAMETER IN INCHES										
GPM	1	1.25	1.5	2	2.5	3	4	5	6	8	10
1	0.02	0.01									
2	0.06	0.02	0.01								
3	0.14	0.04	0.02				**Bold Numbers indicate**				
4	0.23	0.07	0.04	0.01			**5 Feet per Second Velocity**				
5	0.35	0.11	0.05	0.02							
6	0.49	0.15	0.08	0.03	0.01						
7	0.66	0.20	0.10	0.03	0.01						
8	0.84	0.25	0.13	0.04	0.02						
9	1.05	0.31	0.16	0.05	0.02						
10	1.27	0.38	0.20	0.07	0.03	0.01					
11	1.52	0.45	0.23	0.08	0.03	0.01					
12	1.78	0.53	0.28	0.09	0.04	0.01					
14	2.37	0.71	0.37	0.12	0.05	0.02					
16	**3.04**	0.91	0.47	0.16	0.06	0.02					
18	3.78	1.13	0.58	0.20	0.08	0.03					
20	4.59	1.37	0.71	0.24	0.09	0.04	0.01				
22	5.48	1.64	0.85	0.29	0.11	0.04	0.01				
24	6.44	1.92	1.00	0.34	0.13	0.05	0.02				
26	7.47	2.23	1.15	0.39	0.15	0.06	0.02				
28	8.57	**2.56**	1.32	0.45	0.18	0.07	0.02				
30	9.74	2.91	1.50	0.51	0.20	0.08	0.02				
35		3.87	**2.00**	0.68	0.27	0.10	0.03				
40		4.95	2.56	0.86	0.34	0.13	0.04	0.01			
45		6.16	3.19	1.08	0.42	0.16	0.05	0.02			
50		7.49	3.88	1.31	0.52	0.20	0.06	0.02			
55		8.93	4.62	**1.56**	0.62	0.24	0.07	0.02			
60		10.49	5.43	1.83	0.72	0.28	0.08	0.03	0.01		
65			6.30	2.12	0.84	0.32	0.09	0.03	0.01		
70			7.23	2.44	0.96	0.37	0.11	0.04	0.02		
75			8.21	2.77	1.09	0.42	0.12	0.04	0.02		
80			9.25	3.12	1.23	0.47	0.14	0.05	0.02		
85			10.35	3.49	**1.38**	0.53	0.16	0.06	0.02		
90				3.88	1.53	0.59	0.17	0.06	0.03		
95				4.29	1.69	0.65	0.19	0.07	0.03		
100				4.72	1.86	**0.72**	0.21	0.08	0.03	0.01	
150				10.00	3.94	1.52	0.45	0.16	0.07	0.02	
200					6.72	2.59	**0.76**	0.27	0.12	0.03	0.01
250					10.16	3.91	1.15	0.41	0.18	0.05	0.02
300						5.49	1.61	**0.58**	0.25	0.07	0.02
350						7.30	2.15	0.77	0.33	0.09	0.03
400						9.35	2.75	0.98	0.42	0.12	0.04
450							3.42	1.22	**0.52**	0.14	0.05
500							4.15	1.48	0.63	0.18	0.06
550							4.96	1.77	0.76	0.21	0.07
600							5.82	2.08	0.89	0.25	0.08
650							6.75	2.41	1.03	0.29	0.10
700							7.75	2.77	1.18	0.33	0.11
750							8.80	3.14	1.34	**0.37**	0.13
800								3.54	1.51	0.42	0.14
850								3.96	1.69	0.47	0.16
900								4.41	1.88	0.52	0.18
950								4.87	2.08	0.58	0.20
1000								5.36	2.29	0.63	0.22
1500									4.84	1.34	0.46
2000										2.29	0.78
2500										3.46	1.18
3000											1.66

Code Systems

Steve Taylor

Photovoltaics, inverters, and batteries have made major improvements just in the last 10 years. At one time, competing with traditional power sources was totally out of the question. Even now it doesn't really PENCIL OUT, but we are indeed on the threshold of a break even point. For many years, solar panels immediately brought to mind a hippy living in a school bus with panels on the roof. I have known many people that started out in a cabin or bus (including myself). Those people were responsible for bringing this industry into the public view, and to prove that it DOES WORK. This is a very high tech industry, and I feel it should be treated as such. Meeting electrical codes is part of renewable energy's growth process.

Code Compliance

Anyone can go to the book store, purchase the National Electric Code book, and read NEC#690. I recommend that anyone installing their own system do this. But, there is more to it than that. You must open an electrical permit, walk an inspector through the system, and get certified. The problem is that most all other electrical safety requirements apply, whether it is for a solar system, or anything else. So, not only do you have to comply with chapter 690 concerning Alternative Energy systems, you also have to observe standard electrical safety such as: wire type and size, mechanical safety, proper spacing of components of different voltage values, breakers vs. fuses, special signs, and much more. Another problem is that local codes vary from one county to the next. For example, flexible conduit is commonly used here in Washington, but it is not legal in California. Some of the high points the inspector will be looking for is:

Fused Array Disconnect (DC Rated)

This disconnect provides the capability of disconnecting the array from the charge regulator and batteries. This unit should be DC rated, and have fuses of a slightly higher value than the array peak current. In the event there is a short in the array wiring, then the fuse would blow instead of allowing your batteries to send 900 to 2,000 amps through the charge regulator. The disconnect provides fire safety and the convenience in disconnecting the array.

Array Grounding

The solar array mounts and frames should be grounded directly with an 8' ground rod. Grounding reduces the possibility of lightning damage should your system take a direct strike.

Battery Enclosure & Batteries

Battery enclosures vary from one installing dealer to the next, but basic guidelines include: Fully enclosed, and not readily accessible by unqualified or unsuspecting people (such as a 2 year old with a wrench in his hand). This vent should be as vertical as possible, and exit from the highest point of the enclosure. Although it is not required by the code book, the batteries should be well insulated from the floor, so the cold can not conduct directly in. Batteries like to be around 78°F. In most cases, our battery enclosures are insulated to a value of R19 or better, on the floor and all four sides. In warm climates, I would still recommend insulating the battery from the floor. The battery negative terminal should be grounded to an 8' ground rod, along with all other neutral lines in the home.

Inverters

Inverter ac outputs can be hard wired in conduit. Also, the inverter should have fused disconnects on the ac output AND DC input. These fuses should be of slightly higher value than the inverter rated input/output capacities. The inverter ac output fuse and disconnect should be totally independent of the home's main breaker. Inverters should be securely mounted well away from the battery gasses.

Signs & Warning Stickers

Homes with multiple voltage sources such as 12 volt lighting and 120 AC should have signs at both main breakers and outside at the service entry stating something like: CAUTION MULTIPLE VOLTAGE SOURCES. Other signs and stickers include: ARRAY DISCONNECT, INVERTER DISCONNECT, CAUTION BATTERY CHARGING AREA, DANGER HIGH DC CURRENT AREA, 120 VOLTS, 240 VOLTS, 12 VOLTS, 24 VOLTS, ETC. We have these stickers in stock here at the store, if anyone needs them.

There is more to it than the items mentioned, but those are the main ones. You should all consider including them even if you don't want to get inspected. I recommend that all code quality systems should be done by a qualified, established sales, service and installing dealer. Other advantages of a code inspected system include the availability of bank financing, and home owner's insurance. So protect your investment in renewable energy by meeting the electrical codes in your system.

Steve Taylor is the owner of Steamco Solar Electric, the only ARCO Solar® factory trained dealer in the state of Washington. He specializes in code complying, renewable energy systems. STEAMCO SOLAR ELECTRIC, 2700 Cantu Ln. NW, Bremerton, WA 98312 or call 206-830-4301.

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Things that Work!

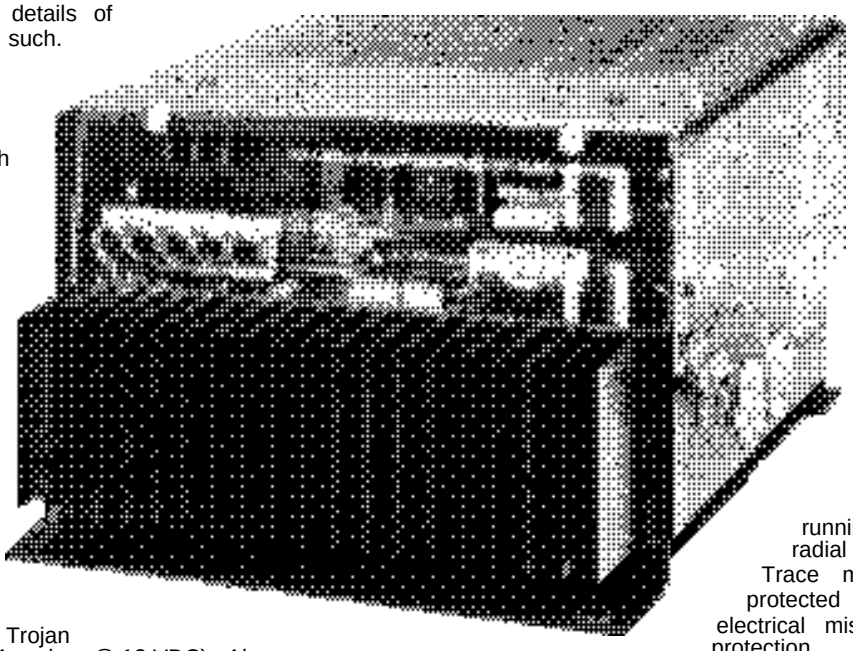
Home Power tests the Trace 2012 Inverter/Charger

The original Trace 1512 was the very first reliable and affordable inverter for home power use. It not only worked, but you needed a shotgun to kill it! Well, the fine fellows at Trace are not resting on their laurels. They are busily integrating the latest MOS FET power transistor technology into their supertough inverters. The result is a 25% increase in overall performance, and (here's the nicest part) at no increase in price.

Inverter Overview

The Trace 2012 is 12 VDC to 120 vac, modified sine-wave, power inverter with an output of 2,000 watts. It also contains an up to 120 Ampere, 12 to 15.5 VDC Battery Charger that accepts 120 vac as input power. The test inverter was equipped with both the optional charger and the digital instrumentation package.

As this series of Trace Inverter/Chargers are the most popular models ever, I'll not waste space with the usual details of size, weight and such. Suffice it to say that the unit is packed well enough to travel to Zanzibar, and documented well enough to be installed and operated by anyone reading English.



Test System

We decided to give this inverter a real workout. We installed it in the largest 12 VDC system in this neighborhood. The Hacker & Nerd Universal Centre was made available to us by Stan Krute. This monster system uses 12 Kyocera 48 W. PV panels to charge 8 each Trojan L-16W batteries (1,400 Amp-hrs. @ 12 VDC). Also present in the system are two engine generators: 1) a 12 VDC Mk. VI system of 100 Amps at 15 VDC, and 2) a Honda 4kW. 120/240 vac generator. A Heliotrope CC-60 PV Controller rides herd on PV recharging of the batteries. The inverter was connected to the batteries via "0" gauge copper cable of ≈3.5 feet in length.

This system is not only large but also contains a wide variety of handy, enormous loads. One in particular, an electric popcorn maker, already has the scalp of one power inverter under its belt. This system's loads vary from ultratech computer gear, to a large radial arm saw.

Inverter Operation

The Trace 2012 performs flawlessly, just like the earlier model 1512. It powered all types of ac loads, including motors and transformers. The 2012 seems quieter in its operation than did the 1512, but this may be subjective since we have no accurate sound measurement instruments. The Trace 2012 resisted all attempts at destruction from overloading. It even survived direct and deliberate shorting of its output. While the inverter was loaded at close to its maximum output, a screwdriver was placed across its output, creating a direct short. The loads stopped operating and the inverter ceased functioning. As soon as the screwdriver was removed, the Trace started inverting again, the lights came back on, and the motors started. The screwdriver wasn't even hot, and there were no arc marks at the short point.

The output of the Trace 2012 is definitely up from the earlier models. It had a much easier time starting and running large motors like the radial arm saw. As with all Trace models, this inverter is protected against just about any electrical mishap. Included in the protection circuitry are: overtemperature, overcurrent, battery overvoltage, and battery undervoltage. The Trace will even survive such carelessness as plugging its output into its 120 vac charger input. Don't try this with other inverter/chargers as it will absolutely ruin them.

The real news here is not the inverter, which is much the same as the previous model but higher in power, but the battery charger. The Trace 2012's charger really kicks butt on large battery packs. Its output is programmable in amperage up to 120 Amps. Voltage limits are user programmable with a wide enough range to even equalize cold lead-acid batteries.

Early models of the Trace charger suffered from low output, not

from any fault of their own, but from the power sources folks fed them with. Engine powered generators produce 120 vac with a lower peak-to-peak (vpp) ac voltage than does the commercial grid. The grid supplies about 164 vpp, while most generators are lucky to hit about 140 vpp. The lower peak voltage output of 120 vac engine generators reduces the charger's output. Well, the Trace 2012's charger performs much better on engine generators than did the previous model's. While Trace claims more modest gains, our 2012's charger output was up some 40% over the earlier 1512 model. The Trace 2012's built-in charger is without doubt the best of its type now available. Operation of the charger is ultra simple. Just plug the ac **input** to the inverter into the generator and everything else is automatic. The inverter stops inverting, becomes a battery charger, and transfers all loads plugged into the inverter to the generator. All automatically!

The digital LED metering package is well worth the cost to anyone using the Trace's charger. It not only measures the DC Amps flowing into the batteries via the built-in charger, but also measures the speed (Hz.) and peak voltage of the generator. This instrumentation makes it a snap to adjust the generators speed so that it produces 120 vac at EXACTLY 60 cycles per second (Hz.). The meter also measures the battery's voltage to two decimal places.

Cost

The Trace 2012 costs no more than did the lower powered 1512s. The price of the inverter itself is $1,090, the charger option-$220, and the digital metering package-$130. For a total of $1,440., it's a very good buy for those requiring an inverter with battery charging capabilities. Trace offers a two year warranty with the 2012 and backs it up with technical support and service that is rapidly becoming famous in the industry.

Conclusions

The Trace 2012 is **THE** power inverter/battery charger. It does everything that Trace says it will, and it's virtually indestructible. This inverter is as tough as a Rhinoceros. It has the finest, most high powered, built-in battery charger available. It should cost more money than it does, but who are we to argue with the folks who make it? Home Power recommends the Trace 2012 most highly to anyone considering an inverter with battery charging capabilities. If you don't believe us, then ask ANYONE who owns one.

The folks at Trace deserve credit for a significant improvement in their already first class product. Other companies would have charged us more money for a new, higher powered, model. But not Trace. Thanks Trace! Incidentally, this fact alone tells you more about the folks at Trace than anything we can say.

Things that Work!

Home Power tests the Heliotrope CC-60 PWM Battery Charge Controller

Up to now charge controllers have been basically voltage sensing switches. Well, Heliotrope has a new approach to battery state of charge control. Their new CC-60 is a real STATE OF CHARGE controller-far more than just a voltage regulator. The CC series of controllers are very well made and can handle up to 120 Amps in either 12 or 24 VDC systems. This PWM (Pulse Width Modulation) controller is an all solid state, series type unit applicable in PV systems.

Control Theory

Heliotrope's PWM controllers use power MOS FET transistors in series between the power source and the batteries. These FETs control the amount of current delivered to the system by rapidly switching on and off the connection between the power source and the batteries. The controller's logic considers battery voltage and BATTERY TEMPERATURE. Once the user has selected the appropriate state of charge (SOC) voltage for his batteries, no further human attention is needed. The control automatically maintains the battery's state of charge, even compensating for the temperature of the batteries. The Heliotrope CC series of charge controllers are totally transistorized and DO NOT employ relays or other failure prone electromechanical parts. They are field selectable for either 12 or 24 VDC operation. The Heliotrope controls are protected against reverse polarity, shorts during wiring, and over temperature.

Shipping Container & Documentation

The CC-60 arrived via UPS in fine shape. The documentation on the unit is rudimentary and reflects the "just out" nature of this charge controller. Heliotrope assured me that a new, illustrated installation and operations manual is in the works.

Physical Examination

The CC-60 is housed in a heavy gray metal box that is 8.25 inches tall by 11.25 inches wide by 3.75 inches deep. There are five status indicator LEDs (Charging, Charged, Overtemp, and Low Battery Voltage) on the control's front face.

The Heliotrope controllers use Shottky blocking diodes, and between 2 and 4 monster FETs (Field Effect Transistors), all heatsunk to a large metal bar within the controller. A hole is included for the optional fan. This fan extends the current handling capabilities of the controller by helping dissipate the heat caused by high current operation. The fan is thermostatically activated, only when needed, by the controller's logic.

All wiring is accomplished from a slot on the bottom of the controller. There are 4 very heavy 250 CFM lugs to connect the power source and the battery. These lugs easily make a durable, low loss, mechanical connection on wire or cable larger than "0000" gauge. We like these godzilla connectors. Their huge size and ease of use make difficult connections on heavy cables a snap!

Battery voltage can be sensed via the main power wires or via dedicated separate wires directly to the battery. Using dedicated sense wiring assures that the battery's voltage is accurately measured and neglects the voltage losses caused by the high current flow in the power wiring to the battery.

Connections are also included for the battery temperature sensor. This sensor is epoxied to the case of a battery and compensates the SOC voltage -3 milliVolts per cell per degree Centigrade. Temperature compensation means that when the batteries are cold, this controller is smart enough to realize the situation and raise the SOC voltage of the batteries. This feature is very good for folks with batteries in unheated areas during the winter. For example, this controller will automatically raise the SOC voltage in a 12 VDC system by about 0.45 VDC between a battery at 78°F. and one at 34°F.

The "Low Voltage" alarm is user programmable to either 10.5 or 11. VDC in 12 VDC systems and 21. or 22. VDC in 24 VDC systems. One nice feature is an on board electronic switch to drive a user supplied 12 VDC buzzer when the battery voltage drops to the "Low Voltage" setpoint.

Installation & Test System

We installed the CC-60 between a 200 Watt PV array (≈16 VDC @ ≈13 A.) and a pair of Trojan L-16W batteries (12 VDC @ 350 A.-H.). The unit is programmable via a DIP switch to state of charge (SOC) voltages between 13.5 and 15 VDC in 0.1 Volt increments. The very same control will also work in 24 VDC systems with a flick of the DIP switch. In 24 VDC systems the

state of charge voltage points are from 27 to 30 VDC in 0.2 increments. We selected an SOC voltage of 14.4 VDC for our test system. Once it was wired up we sat back and watched it do its stuff.

Control Performance

When the system's batteries reached the state of charge set point we selected, the PWM controller began to rapidly switch the array on and off. The voltage set point was roughly maintained regardless of solar insolation and system electrical usage. When the voltage set point is reached the "Charging" LED goes out and the "Charged" LED lights up.

While the controller was regulating we switched some loads on. The controller sensed the loads and the energy flowing from the PV panels was increased to compensate for the added electrical consumption. When the loads were removed from the system, the controller once again reduced the array's current to the batteries.

The Heliotrope CC regulators are not voltage regulators per se. They are Battery State of Charge Regulators. Something new… As such, it took us a while to understand how it works. We were expecting a voltage regulator, what we got was far more. A small electronic computer with only one mission in life- your battery's well being. The CC controllers will maintain system voltage within about 0.2 VDC in 12 VDC systems. The CC-60 responded to changes in system voltage rather slowly- just like the batteries. The transition from heavy regulation to no regulation took our CC-60 about 7 seconds. Those looking for a voltage control that responds rapidly to large transients are advised to look elsewhere. These units are not voltage regulators, but Battery State of Charge controllers.

We've had our CC-60 on line for about 6 weeks now and have experienced no problems with the unit. It does its job flawlessly, with absolutely no user participation. Whenever our batteries are full- it keeps them there and maintains the system's voltage at acceptable levels for all our equipment.

Cost

The basic CC-60 costs $165. and will handle 45 Amps. The addition of the optional fan for $36 will extend the CC-60's current limit to 60 Amps. There is also a 120 Amp version that employs 4 FETs and a fan, call Heliotrope for pricing. Heliotrope also offers a 20 Amp version of this control with current and voltage LED bar graph metering.

Heliotrope's warranty deserves mention and emulation. If the device fails during the first year replacement is made at no charge. For years 2 through 5 replacement will be made for a service fee not to exceed 25% of the current list price and for years 6 through 10 for a service fee not to exceed 50% of the current list price. The very fact that Heliotrope can offer such a wonderful warranty is a tribute to their intense dedication to quality control.

Conclusion

We recommend the Heliotrope PWM Battery Charge Controllers. They are a new approach to battery state of charge control. A dedicated computer that keeps your batteries as full as possible. They offer extremely reliable, high current, operation at a reasonable price. The Heliotrope unit is well made and backed by a super warranty. We're proud to have one in our system.

Contact Heliotrope General at 3733 Kenora Drive, Spring Valley, CA 92077 or phone: in CA 800-552-8838 or outside CA 800-854-2674.

THE POSSIBILITY OF CHARGE-ENERGY SIMILAR TO MASS-ENERGY

When we look at the electron-positron annihilation reaction we see that the property of the interactants called mass is transformed into a type of energy which we normally call light. As we all should know, this process is represented by the famous equation:

$$E = m*c^2$$

Here, E is the energy produced, m is the mass transformed into energy, and c is the speed of light.

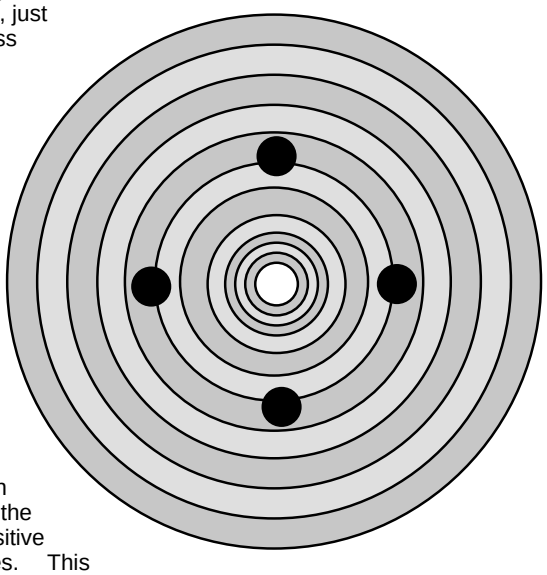
Now, since we have seen that this process is essentially true, it is valid to ask what happened to the property of the interactants called charge. Looking at the action of mass we see that it seems to create a force field of the form:

$$F = (G*m_1*m_2)/(r^2)$$

However, when we look at the action of the property called charge, we see that it seems to create a force field of almost identical form:

$$F = -(K*q_1*q_2)/(r^2)$$

From the above considerations one is forced to conclude that there exists a type of charge-energy into which the property of charge is transformed, just as the property of mass is transformed into photonic energy.



One of the major differences between this new type of energy, which may be called for the moment tachyonic, and normal photonic energy is the fact that it is **dipolar**. That is, although it may not measurably exhibit the property of charge, it will contain within itself the properties of both positive and negative charges. This energy should be observable in electron-positron annihilation reactions, using large electromagnetic fields to separate the charges spacially, thus rendering them visible in properly constructed environments. Although this new tachyonic energy will exhibit electromagnetic properties, we believe that in its energy dipole form, as opposed to its unipolar charge forms, this new energy form is really the **graviton**, or more properly, the **magneto-graviton**; that energy form actually responsible for the force of gravity. In saying this we are laying the foundation for a unified field theory, wherein the unipolar forms produce the normal electromagnetic effects and the dipolar form produces gravitational effects due to its structural configurations in the bound state. Essentially, gravitational forces become explainable in terms of electromagnetic interactions between the bound dipolar tachyons in matter.

The next thing to consider is the question of how this new possiblity affects modern physical explanations of the way the universe works. The first conclusion one is led to is that the structure and form of all matter has evolutionary sequence at its most basic level. The process would seem to go something like this. Space radiates energy in photonic and tachyonic forms. These two energies interact and begin to form globules of primordal matter, in a non-separated charge state, similar in structure to matter inside a black hole, but without the gravitational effects. These globules form systems similar to solar systems and begin to exhibit charge separation. At this stage the structure is probably similar to that of matter in a neutron star. Next, some total charge separation takes place and we have the beginnings of matter as we normally know it today. What one must **not** assume is that the evolution of the structure of matter is finished; this is highly unlikely.

Next we will show you our conception of a static cross-section of the dynamically changing modern-day electron. As you can see, this consists of four (-1/3) charges in a tetrahedral configuration with one (+1/3) charge at the center. Surrounding these charges, both within and without the tetrahedral volume, are regions of bound photonic & tachyonic energy.

- (1/3) charge

+ (1/3) charge

bound tachyons

bound photons

A similar situation exists for all elementary particles. For positively charged particles the charge configuration is reversed. In the case of neutral particles there is an eight vertexed double tetrahedron with a dual center consisting of separate positive and negative charges. In all these cases there are greater concentrations of bound photonic and tachyonic energies.

In the case of neutinos the situation is slightly different. Neutrinos, we believe, have no split charge configurations. Those without rest mass have essentially a two-dimensional structure of bound tachyonic and photonic energies, while those with rest mass exhibit a centerless three- dimensional configuration similar to that of the electron. We must remember

that the structures described above are only one out of many possible views of a dynamically changing matrix.

One might be tempted to wonder whether the conclusions invalidate the deductive processes that arrived at them. Not at all. It is explainable as follows. The amount of bound photonic energy of a particle at rest is directly proportional to its bound tachyonic energy.

$$m_0 = (\text{Constant}) * (\text{Tachyonic Energy}) / (c^2)$$

It is thus still a proper quantity to be used in the gravitational force equation. In the case of the photo-electric effect, it is this proportionality that causes the photon to be re-emitted and not kept bound within the electron matrix.

The gravitational constant (**G**) is a measure of the general structural configuration of the bound tachyons in a particle at rest. It is essentially a probability distribution function integrated over the space-time volume of the particle in question. **G** also varies with velocity, thus being looked at as **G(v)**.

We may now look at how this new view relates to a particle in motion with velocity **v**. Two things happen. First **G(v)** increases due the the interior realignment of bound tachyons created by particle motion. This increases the gravitational field and gives rise to the measured increase in mass at a given velocity. Secondly, the energy of the bound photons is increased; that is, their frequency becomes greater. This is due to the nature of the tachyon-photon binding interaction, and causes the measured increase in the energy of mass annihilation reactions when the particles concerned are in motion. We may now look at the gravitational force equation for two particles with rest masses m_{01} and m_{02}, and velocities v_1 and v_2:

$$F = (\{G(v_1) * G(v_2)\}^{1/2}) * m_{01} * m_{02} / (r^2)$$

The energy equation for annihilation would be:

$$E = (m_{01} + m_{02}) * (c^2) + \{(h) * (\sum\{(n_j) * (\Delta f_j)\})\}$$

As in classical relativity, we believe that these equations have maxima at the velocity of light, but unlike classical relativity we do **not** believe that these maxima are infinite - just very, very, large. We must also consider here the form of the energy equation for charge annihilation. Just as the energy equation for mass has two parts, we believe that the charge equation also has two parts; an electrostatic part corresponding to rest mass energy, and an electromagnetic part corresponding to energy due to velocity. The above ideas give formerly abstact considerations such as those of kinetic energy, heat transfer, time dilation, and the like a much firmer, more objective basis of consideration.

Next, we will consider the strong and weak interactions. The weak interaction is simply a type of low level electromagnetic resonance. In the case of neutrino capture by an electron, this resonance is set up within the electron matrix between the tachyons and split charges of the electron on one side and the tachyons of the neutrino on the other. This is very similar to the photoelectric effect. However, the resonance here being tachyonic, the matrix and actual nature of the particle is changed, while in photon capture and re-emission this is not the case.

The strong interaction is, on the other hand, similar in nature to the gravitational force. However, because of the closeness of particles in the internuclear matrix, the actual pathways of the individual bound tachyons, and probably those of the split charges, must be taken into account, in order to properly determine the field interactions of such a dynamically changing structural matrix. Practically, this results in having to evaluate the probability distribution function of structural configuration in a discrete manner, as opposed to a continuous integration, in order to arrive at a value for **G** valid at internuclear distances.

In a similar manner, we believe that the value for **G** must be evaluated differently for distances on the order of those existing between local super-clusters of galaxies. Due to the configuration of fields and forces interacting at these great distances, it is believed that the value for **G** becomes negative at these distances, thus accounting for the measured recessional motion of far-off galactic groupings.

The above considerations must now lead us to the formulation of **G** not only as a function of the velocities of the matter involved, but also as a function of the distances between them. Thus, we now see the gravitational constant as **G(v,r)**.

We may now take a quick look at quantum and wave mechanics. The uncertainties in these two disciplines comes from their probablistic natures. However, these uncertainties are founded upon the basic dynamic configurations of the bound energies in question. Were we able to determine the structure of the individual paths of the bound photons, tachyons, and split-charge configurations within matter, then these uncertainties would disappear. This is demonstratable by considering the tunnel diode effect. This effect is explained by saying that an electron has a certain probability of being on the other side of a potential barrier that it could normally never cross. However, if we consider the dynamic structural configuration of the electron, we may see that a certain percentage of electrons have the proper spacial configuration at just the right moment to naturally pass through this potential barrier. The magnitude of this percentage should be found to be exactly the same as the probability for a single electron to cross this barrier, as calculated by present day methods.

What type of technology might flow from this new way of looking at the universe of matter? By proper configuration, alignment, and manipulation of electromagnetic and dipolar electromagnetic fields, the technologies of anti-gravity, faster than light travel (without the elusive concept of hyperspace), cold fusion, and safe fission (with little or no by-products) should be available in the future. Also, such futuristic devices as matter transformers, matter duplicators, matter transmitters and tractor beams may be possible. The first step here is to attempt to simulate the type of field produced by a tachyon. One possible way to do this might be to wind two very small insulated wires in a circular, double helical pattern. They could be either wound around each other, or around a torus. If the latter, the radius of the tube should be very much less than the radius of the hole. Current could then be passed through the two wires in opposite directions, thus simulating plus and minus charges moving in a bound circular path, in the same direction, as would be in our conception of the tachyonic structure. We believe that the double helical form is the correct simulation of the interior structure of the bound tachyonic path, although the actual configuration of a free tachyon may be more akin to that of a double spiral.

In view of the above, it is likely that there is an evolutionary relationship between tachyons and DNA on one hand, and one also between tachyons and the formation of spiral galaxies on the other.

While considering the totality of our viewpoint, we have had to come to certain conclusions that are at variance with modern physical theory. These include the following: space continually radiates energy; there was no big bang; black holes have no singularities. However, the most astonishing conclusion we reached is that the electromagnetic spectrum actually consists of two very different types of entities. The first, of which radio

waves are the best known representative, are created by charge oscillation and are actually projected force fields whose method of operation is that of a normal force field. The second, represented of course by light, are created from the photonic component of matter and work essentially by direct energy transfer. The former also have a third vector force produced by tachyons, which force is responsible for the bending of these waves near a large mass. The bending of photons in similar fields is, however, a function of the same tachyon force responsible for the binding of the photons in material structures. It seems to us as if these are two entirely different phenomena even if the mathematics of their existence are the same.

Addendum to Tachyon Theory

After much meditation and questioning we have come to the conclusion that the entire physical and even part of the metaphysical universe can be seen as manifestations of tachyon groupings.

In this mode photons are seen as charge balanced tachyon manifestations with straight line symmetry. Mass is seen as a charge balanced form with circular or spherical symmetry. The individual plus and minus one third charges are charge unbalanced manifestations also with circular or spherical symmetry, with the tetrahedral symmetry of their interrelation remaining. Finally, the neutrino is a charge balanced form whose symmetry relates to the tetrahedral and may be triangular, tetrahedral, cubic, or octahedral.

Mathematically, this entire idea can be described by a general tachyon function and a sequence of charge symmetric and charge asymmetric geometric operators. The results of applying these operators to the general function are the mathematical descriptors of the above related forms.

In this theoretical model the strong interaction would be produced by the short range interaction between one third charges of opposite sign. The weak interaction would be produced by the short range interaction between one third charges of like sign. These fields would necessarily have fine structure based on the tetrahedral form of the charge distribution.

We know from General Relativity that the mass aspect can be seen as a continuous Space-Time curvature. Looking closely at Quantuum Mechanics we find that the charge aspect might also be seen in terms of like curvature but in a quantized manner. This is most evident in the theory of electron orbitals. This leaves open the possibility of a Unified Field Theory based on the Space-Time curvature produced by the various tachyonic forms.

This theory also provides room for latent unstructured tachyonic forms which may provide a basis for energy transformations as yet unexplained and such processes as quantuum mechanical correlation. Another function for these latent forms would be to provide a basis for an entirely new level of substance manifestation. This level would not be involved in mass or energy transformations but in the manifestation and transmutation of information matrices. Mathematically, this requires a whole new set of operators which may collectively be called the descriptors of creative imagination. **The future is before us. let us explore it now.**

Good Luck. And **May The Force Be With You.**

Things that Work!

"Electro-Bed-Warmth" Bed Warmers

Windy Dankoff

On the coldest nights of winter, our favorite electrical appliance is the electric bed warmer. Conventional wisdom dictates that "space heating" on PV, wind or small hydro-electric is not feasible, but here is one exception. Major comfort is provided by a small input of energy, when applied directly to the surface of your mattress--for a double bed using a thick quilt or comforter, only a few amp-hours (50 watt-hours or less) is all it takes to warm the bed IF your bedroom is COLD like 50 degrees or so. This is the typical energy output of a single 40 Watt (1 x 4' $300) photovoltaic module on a half-cloudy day in winter! The bed warmer allows you to keep a bedroom relatively cold, and still get a very good night's sleep while saving LOTS of heating fuel.

A few years ago, Anne and I lived in a converted bus on 100% PV power. We would come home sometimes at night to a 40 degree inside temperature. All we had to do was turn on our 55 Watt (4.6 Amp) 12 Volt warmer for about 20 minutes and we had a nice warm bed to crawl into. After that, we usually turned it off completely. The coldest nights are the clear ones, usually corresponding to the SUNNIEST days of winter, so we never found it to be an excessive energy drain.

A Bed Warmer pins directly to your mattress -- a much more efficient way to apply heat than the usual electric blanket. "Electro-Warmth" is a top-of-the-line bed warmer, produced since 1938. Among the many sizes and models is a line of 12 Volt warmers, made for recreational vehicles (RVs) and sleeper cabs in trucks. Paul Wilkins (Editor, PV Network News) has been using one in his camper van for over 10 years. We've been using it for 5 years. They are rugged, safe and reliable, and made primarily of cotton. One customer of ours had a failure long after the 1 year warranty period, and it cost him just a few $ to have it factory repaired. Electro-Warmth bed warmers are a long-term investment.

Bed warmers are perhaps the only electric heating device that can greatly reduce your home or RV heating costs! Next to a good mate (or underneath one) the "Electro-Warmth" Bed Warmer can be your best companion on a cold winter night. Prices range from $45 to $60, from Home Power advertisers: FLOWLIGHT SOLAR POWER and ALTERNATIVE ENERGY ENGINEERING.

Windy Dankoff is the owner Flowlight Solar Power, a mail-order supplier of home PV systems and manufacturer of PV powered well pumps. Windy's shop and home are solar-powered. He may be reached at POB 548, Santa Cruz, NM 87567 or call 505-753-9699.

Things that Work!

Home Power tests Backwoods Solar's LED Christmas Lights

It's not often that Technology and Serendipity combine to make something perfect. Backwoods Solar sure has done it this time. Their LED Christmas lights are the bee's knees.

LEDs?

The LED (Light Emitting Diode) is a marvel of semiconductor technology. You know, those cute red, yellow or green lights that inhabit almost all electronic equipment. The LED makes light in a different fashion from either an incandescent or fluorescent source. The light coming from an LED is produced by electrons as they cross a semiconductor junction. As an electron traverses the junction, it loses energy in the form of visible light. The frequency (or color) of the light depends upon the type of junction in the LED. Some junctions have an energy band gap that allows the electrons to lose energy as red light, some green, and some yellow.

Production of light within the LED produces virtually no heat, requires only a couple of volts, and best of all, lasts virtually forever. Mean Time Before Failure for LEDs is measured in human generations. There is every possibility that your great-grandchildren will still be using the same LEDs you are using today.

Christmas Lights

LEDs make ideal decorative lights. The color of the light they produce is very pure. The reds are super red with virtually no other color present. Same for the yellows and greens. This is due to the nature of the LED junction.

LEDs are the most efficient light producers that technology has ever developed. They require only miniscule amounts of power to operate. Being low voltage and cool running, the LEDs are extremely safe.

Well, Steve & Elizabeth Willey, and the Crew of Backwoods Solar are making strings of LEDs. These strings contain between 6 and 18 LEDs configured for direct 12 VDC operation. The LEDs are about six inches apart. The string of 18 LEDs consumes 0.060 Amperes at 12 VDC. The LEDs are soldered to the wiring and shrink tubing is used to insulate the connections. The strings are very well made and should last several lifetimes. In fact, Backwoods Solar says they fix 'em for free should they ever fail.

The strings are fused and polarity is identified. Not that there is any danger or damage should the string be hooked up backwards. The LED strings are available in red, green, yellow, or a mixture of any or all.

Using the LED Light Strings

These LED strings are far too nice to be used only at Christmas, eventhough they are ideal on a tree. A friend of ours, Butch Russ of Callahan CA, has a set that spends most of its time on his porch railing. It softly illuminates his steps, providing safe access to his home with minimum power consumption.

We strung a double set (36 LEDs-all colors) up on the ceiling of Home Power Central. After my eyes adjust to their lower light output, they provide more than enough illumination to navigate the room. I hooked the LED strings to a programmable pulse generator and flashed all the LEDs at around 8 times per second. The effect is spectacular!

Conclusion

Backwoods Solar's LED Light Strings are not only well made, but the very essence of just plain fun. They are useful to softly illuminate paths, steps and rooms. The strings provide safe, decorative light with extremely low power consumption. Being 12 VDC operated and weatherproof, the strings are ideal for outside lighting. They cost $12.50 for a single string of 18 LEDs, add $5 for a built-in flasher. Double Strings (36 LEDs) at twice the price.

Contact Backwoods Solar at 8530 Rapid Lightning Creek Rd, Sandpoint, ID 83864 or call 208-263-4290.

Things that Work!

Home Power tests the Telemobile Radio Telephone System

We **had** a problem here at Home Power/Electron Connection Central. I emphasize the word "had" because we don't have this problem anymore. Instead we have a telephone. The situation was critical. We were trying to run a publication coordinating over 8,000 readers and 40 advertisers nationwide without a telephone. Our site is far too far from any sort of hardline. Instead we opted for a dedicated radio link to bring telephone service to our remote location. And it works.

Radio Telephone (R/T) Overview

The Telemobile R/T system interfaces between the regular telephone line and a remote site via two way radio. One section of the system is connected to a standard telephone line at a location where telephone service is readily available. This base unit then talks to the remote unit via radio. The remote unit has no actual physical connection to the base and may be located up to 15 miles away. The system is full duplex, meaning that you can both talk and listen at the same time. Operation is identical to a regular hardline telephone and most callers in don't know there is a radio link in use.

Physical Examination

The Telemobile system consists of two black boxes each 4 inches high, by 7.3 inches wide, by 12 inches deep. Connections are provided for power (either 120 vac or 12 VDC models are available), radio antenna, and a standard jack for a telephone plug. I opened the cases of the Telemobile R/T and found high quality printed circuit boards jam packed with radio components. The quality of the components and construction appears excellent.

The documentation in the owner's manual is quite skimpy, limited to installation and operating essentials only. Fortunately, Jim Carlson provided us with the factory service manuals which are very complete.

Test System

We installed one end of the system at the business telephone line we had at Stan Krute's Hacker & Nerd Centre. This location is about 4 airline miles from us and has buried phone lines nearby. Power at H&N Centre is 12 VDC via PV panels and batteries. The antenna used on this particular UHF (ultra high frequency) system is a 12 element yagi type with a boom length of about 3 feet. The antenna is mounted on a 36 foot telescoping mast and fed with heliax coaxial hardline. The other end of the system is located at Home Power Central. A yagi antenna of 8 elements is on a 36 foot pushup mast. This end is fed with RG-213 coax. The remote here at HP Central is also 12 VDC powered via PVs and batteries.

We had extensive installation help from Jim Carlson of Carlson Electronics. Not only was Jim able to specify our system using topo maps, but he also came to our site and got the whole thing working! He also obtained the necessary FCC licenses for the system. In this day of mass merchandising, it is unusual to find a group willing to provide personal service, thanks Jim.

System Operation

It works very well indeed! The Telemobile's operation is totally transparent. It operates just like a regular telephone. Pick up the handset and dial. When you're done just hang it up. No special codes, radiotelephone operators, and none of the vagaries we have come to expect from radiotelephone systems. The quality of the FM (frequency modulated) audio is excellent. Our UHF system maintains constant communication over a less than ideal path. You see, even though the radio path between the units in our case is short, it is NOT line of sight. We shoot through, around, or maybe even over several large hills with our radio signal. And it still works reliably.

The Telemobile system doesn't come with a telephone handset. And this is an unusually nice feature as it allows you to use virtually any piece of standard phone gear in the system. Most R/T system offer only their built in phone. Telemobile R/T systems will operate regular, off-the-shelf, telephone equipment such as answering machines, cordless phones, or even a Mickey Mouse phone. The power required by this ancillary phone equipment is produced inside the Telemobile black boxes, where 12 VDC is converted into ≈40 VDC for the phone equipment. We like this unique feature as it contributes to the flexibility and transparency of the system.

The system's receivers (both operating **all** the time at both ends of the system) consume about 40 Watt-hour per day each. The transmitters consume about 155 Watt-hours per day each with our fairly heavy phone use. I figure that the power for the system can be produced by two 48 Watt PV panels, one at each end of the system.

The Rules of the Game

These systems are FCC licensed. This is best left to the folks selling and installing the system. There are literally yards of paperwork in triplicate. The FCC only wants to license business or other official type organizations. Seems individuals don't count… Well get organized or businessed or whatever it takes to make the license legit. Jim Carlson can be of invaluable help in the licensing procedure. Nuff said.

The telephone line is a regular type line. The phone company adds NO additional airtime charges as they do with their proprietary IMTS radiotelephone systems. The user owns all the equipment, and once it's paid for, that's it. No large disturbing monthly bills from Ma Bell, as the phone is billed just like any regular telephone.

You must have a radio path to make the system work. There are limitations involved with radio communication. For example, the R/T antenna here at HP Central was blown off course during a heavy wind storm. The resulting antenna misalignment caused our system to be unreliable until I discovered what the problem was and set the antenna straight. The distance, terrain and weather are all factors that can affect an R/T system's performance. Because every situation is different, Telemobile makes several different models of their R/T system. Some are long range VHF models, while other are shorter range UHF

models. It is best to seek the help of someone adept with radiotelephones to find out what system best meets your needs.

Testing… Testing…
We are still evaluating this system. We are planning on running computer data via modem over the Telemobile R/T. We also want to try it out with a FAX machine. Both these projects are on the back burner until this copy of HP is in your hands. According to Jim Longnecker, the R/T Techie at Carlson Electronics, the Telemobile is capable of 1200 baud modem transmission and FAX service G2. If you want to hear a Telemobile unit in action give us a call at Home Power/Electron Connection Central (916-475-3179).

We've had the Telemobile R/T system working for about 3 months now. The initial black boxes we installed proved to be escapees from the factory quality control line. The remote had very low outgoing audio and everyone we talked to complained we sounded distant. Jim Carlson rushed us a new set of black boxes, and these were properly tuned. The new black boxes are in place now and the audio is fine. Jim assures me that all R/Ts leaving his shop are now checked for tuning and performance before they go out the door. Once again, service like this is hard to find.

Cost
The cost of these systems vary with the type required. A typical system will consist of 2 transceivers, 2 antennas and 2 feedlines. It will cost in the neighborhood of $3,500. The user supplies the masts (about $60 each), and sees to the installation of the telephone company's hardline. The vendor (in our case Carlson Electronics) takes care of the specification, installation, and licensing of the system.

While this is not cheap, it is much cheaper than any alternative available to us. The telephone hardline would have cost over 10 times this amount. Simplex RCC R/T services, with their multiple users and operators, were not suitable for business use. We had already tried the phone company's mobile service (IMTS) for over two years and found it super expensive. IMTS gear is initially cheap, but the phone co. charges about a buck a minute to use their repeaters. With only **minimum** usage, the IMTS system yielded us phone bills in the $400 to $800 per month range. At that rate the one time initial investment of $3,500 for a Telemobile system would pay for itself in less than a year.

Conclusion
The Telemobile radiotelephone system is a working solution for back country phone communication. The system is reliable, easy to use, and far less expensive than installing a hardline. It is very user friendly and indistinguishable in operation from a regular telephone. The Telemobile system accepts standard telephones and off-the-shelf phone accessories. Since the user owns all the hardware, the system is billed by the phone company as a regular telephone. Power consumption of the system is very low, making it a natural for use in remote renewable energy systems.

Contact Carlson Electronics at 774 Redwood Drive, Garberville, CA 95440 or call 1-800-283-6006 or 707-923-2345. The system's manufacturer is Telemobile Inc., 19840 Hamilton Ave., Torrance, CA 90502, or call 213-538-5100.

Carlson Electronics

I Got One Here Somewhere

or What to do when Radio Shack is 50 miles and it's snowing…

BOB-O Schultze KG6MM

I'm a hacker. No, no, I'm not into viruses, bugs, and such, in fact I don't even DO computers. Oh, I know enough bits about bytes to hold up my end of a conversation at a party, but I just don't get off on digital. Keep your And, Or, Nand, Nor Flip-flops. Gimme your diodes, transistors, capacitors and 'simple' IC's like 555's, OP Amps and Voltage regulators. Now we're talkin! And I'll take my components with real wires coming out of 'em, thank you, none of that surface mount stuff that requires the hands of a brain surgeon to fix. No, ya see, I'm an ANALOG hacker. Mid-tech, if you will.

So?

I like to fix things and being as I'm into radio too, my neighbors tend to drop by with most anything having a speaker attached to it that no longer works. Some get a quick inspection, a quicker blessing, and are summarily consigned to the 'junque' box. Most are quickly repairable, IF you have a good stash of parts. For all of us who are quantumly-less-then-wealthy, there's the rub.

The Solution • Mail-order parts stores.

With a little forethought and something like HALF the money you'd spend at Radio Shack, you can have it right there, waiting. Wait, there's more. How many times have you had an idea for some circuit or improvement but didn't get 'round tuit' for want of a handy 50 ohm pot or whatever? There went the vacation home in Tahiti!

Access •Here are some of my favorites:

Jameco Electronics,1355 Shoreway Rd,Belmont,CA 94002.

For new (not surplus) parts and components, these guys are hard to beat. How's this-LM317T voltage regulators (see HP 5,6) 65¢ (Radio Shack-$1.99), 555 timer-29¢, 1N4001 diodes 10 for 70¢, 1/4 watt pots-15¢, .01 ceramic caps-10 for 80¢. Portable butane soldering iron (a real goodie)-$19.99 (check RS at $29.99). On and on, etc. and etc. 70 pages worth. Free catalog. Only drawback is $20. minimum order, but for $20. you can stock your component larder, but good!

Fair Radio Sales, POBox 1105, Lima, OH 45802

Hacker's heaven. 'World's Finest Electronic Surplus' Wonderful goodies and junque and ridiculous prices. Relays, knobs, switches, meters, oh my! Cheap. Remember the 25 Watt, 250 ohm rheostat called for in HP#2 as an alternator field controller? A buck and a half. Love it. $5.00 min. order, free catalog but you may have to wait for the spring printing as they go fast.

Hosfelt Electronics Inc., 2700 Sunset Blvd., Stubenville, OH 43952

Oddball fun surplus stuff. Low voltage gear motors, 12VDC brushless muffin fans (quiet,very), mic cords, power cords, switches, connectors and adaptors to connect and/or adapt anything to everything, tools, thermal switches (make a heat-actuated circulating fan gizmo for yer woodstove!), tons of other neat stuff. Free catalog, NO min. order.

I'm sure other HP folks can and (hopefully) will write in with others, but these are the funnest we've seen. Have fun!

Letters to Home Power

Greetings,

As a result of your touting Solar Retrofit Consortium's fluorescent valance light, Model 88 SVL, I ordered one. Unfortunately, it arrived, via parcel post, with damage to the fluorescent tube so that it didn't work. I wrote to the company and promptly received a replacement tube via UPS 2nd Day Air.

I agree with your praise of the fixture and wanted you to know that the company was also worthy of praise in its considerateness for its customers. Sincerely, Jack Lesh, Gustavus, AK

Dear Folks,

First of all, thank you for putting out a truly interesting and useful publication.

Second of all, we run our homestead and soap manufacturing business on a PV, micro hydro and propane power system. Your drag-a-mouse article is the inspiration for this letter!

We live in the mountains of Northern California on land we purchased in 1977. In the winter of 1978-79, when our two oldest children were reading well on their own, we put wall hanging kerosene lamps on each side of their room. From that moment we lived in fear of the inevitable pillow fight burning down the home we had worked so hard to build. Thus began

our affair with alternative energy!

Originally, we put R.V. lamps in the kids room and a couple of lamps elsewhere in the house, powered of of an old car battery that we charged every time we went to town.... Town being a minimum 1 hour drive (one way), we would weave jumper cables from the truck battery through the passenger side mirror and door handle and into the back of the truck to the house batteries and drive off. It was important to remember NOT to get out of the passenger side door!

Well, we've come a long way since then, and now have what we call the SIMMONS RAIN OR SHINE SYSTEM. Still being perfected, of course, as we can afford panels and such one at a time only. Starting with winter, the rain side of our system is a Harris wheel, powered by the runoff from a pond. Running a 2" pipe down a 70' drop generates all the power we need during the rainy season of long nights. Charging two L-16s, we run lights, stereo, VCR and radio telephone, occasionally using our ancient Radio Shack 300 watt inverter to power our blender (an ancient 250 watt Proctor Silex) and misc. small power tools.

Come the sun in the spring and our assorted PV panels take over, as the water table drops. During those terrible rainless, cloudy times in spring and fall, if they last too long, we hooked an (also ancient) Kohler 2000 watt generator into our system.

Visitors to our home rarely realize that we are not hooked into the power grid. Looks like any other house, with lights and plugs and all.

We also have a solar electric fence to separate our livestock from our vegetables and fruit trees and solar hot water panels.

This is all supplemented by heating with wood, cooking with propane (summer) or on our cookstove (winter), a Paloma instant water heater for winter supplement and a propane refrigerator.

The soap shop has it's own motley assortment of PV panels, charging a couple of 12 volt deep cycle batteries to run lights, radio, and an assortment of ventilating fans that aid in the curing of the soap. We heat with wood and have converted a steam kettle over to propane for our soap making.

YEAH!! People always act like this is impossible!

Anyhow, I was delighted to see the Drag-A-Mouse ad in Home Power. We've wanted to advertise with you (and support your good work in that manner) but suspected that a soap ad would be out of place even if our logo IS the sun! No More! By God, we do have alternative energy soap and we know you all have to wash sometime, so enclosed please find our check and ad copy for your Home Power Mercantile section. Thanks for the opportunity. Keep up the good work. Best Wishes, Dennis and Dottie Simmons, 42295 Hwy. 36, Bridgeville, CA 95526

We've had a few complaints about nonRE ads, but gosh, everybody has other needs AND as our database grows production expenses grow too, AND we REALLY want to keep Home Power Free so we gladly except nonRE advertising. By the way, we sent one of the Simmons Gift Baskets to Richard's Mom and she loved it! KP

Enclosed please find my check for $6 for issues #2, 3, and 4. My originals burned when my alternative energy powered country home was struck by lightning on August 1.

Ironically, I got issue #6 with Windy Dankoff's "Grounding and Lightning Protection" about a week after the fire. It appears that a huge static charge built up on my ungrounded 2,200 pounds of lead calcium batteries and drew the lightning through the house, causing a fire which burned it to the ground. The insurance company says it is the first true 100% loss they've ever adjusted, because the heat was so intense even the foundations and slab buckled and cracked. Nobody knows quite what happened, though. Both I and my neighbor were in town when the fire started. Another irony: the reason I was in town was to work with a fellow from the Tides Foundation of San Francisco on a commercial hazardous waste incinerator public information project.

My Harris microhydro turbine and photovoltaic panels survived. My system differs from Harry O. Rakfeldt's in that I have a high flow (minimum of 105 gpm), low head (50 feet) system, where water is diverted on BLM land from a spring-fed creek and flows a quarter mile to an irrigation reservoir on my property through a four inch pipeline. The turbine is at the end of the pipe.

I will be rebuilding with a grounded system and one whale of a lightning rod! Sincerely, R. C., San Juan County, UT

Greetings,

Here's another big THANKS from those of us out here on the trailing-edge of technology. I eagerly look forward to each issue full of USEFUL information and connections to suppliers. Enclosed is a small donation in lieu of a subscription.

Enjoyed seeing your set-up in #7, warts and all. Most of us build a house to store all our junk - it's nice to see a house built with more important things in mind like supporting radio antennas! Besides "it's not what you've got, it's how you use it" that's important. All the info that springs out of the plywood palace is real important to your readers.

If you're looking for suggestions for future articles here's a couple of subjects I'd like to see addressed 1) 12 volt washing machine possibilities and 2) building your own PV modules. Are either feasible and cost effective?

We're still at the 12 volt generator/battery storage stage of development. PV's are definitely in our future but I'm told there's a washing machine (or lack there-of) standing between us and them.

Keep up the great work! A.L., Misty Ridge Herb Farm, Chimacum, WA

Dear Friends,

We first came across your publication at this summer's Country Fair in Veneta, Oregon. Since then, with the help of my brother-in-law, we have set up 2 Kyocera panels. Lights, after 5 years of candles! From the stone age to the space age! WOW!

The lights have not replaced the candles completely as we still love the soft glow of candles. There is obviously a place for both forms of energy. Our 13 year old son, with a mischievous glow in his eye, suggested placing an array of candles in front of the solar panels. Another alternative to a wind, hydro or generator back-up system, if you will.

Leo Morin who advertises in your publication as "Free Energy Options" gave very generously of his time in answering my many questions and helping me understand alot of the basics of photovoltaics. I would recommend him without reservations to anyone contemplating energy alternatives who lives in our neck of the woods, which in this case is Eugene to the coast of Oregon. He is very conscious of keeping the cost down and building with the option of expanding later, if you desire, incorporated into his recommendations. Enclosed is a small contribution as a way of thanking you for your publication. May the "Force Be With You", Gerry & Nancy, Florence, OR

Dear Home Power,

The editor of an outstanding popular magazine reported that within a dozen years species of all kinds will begin to disappear at the rate of one every hour. The greatest thinkers of our time agree that if progress and growth perpetuates on the popularized course that it has enjoyed during the last fifty years life, as we know it will come to an end within three generations. The environmental consequence is a collective effort which grows

and grows. The people of the world have gradually molded for themselves a united destiny which all life has to bear. Unfortunately, we must say that the sad environmental situation was self-earned. All of the natural problems could have been solved easily. We had the brains, but not the goodwill.

What then is the hope for the world? There is only one hope -- to administrate truth. People must honestly strive to understand the law of consequences. The principle of conservation can be expressed in Newton's Law of equal return. Whatever we do to the land, the air and the natural environment will pay us back with good fortune or eliminate us from this planet.

Farmers everywhere are contributing to the silent spring; the forest industry and the Forest Service are not complying with well known environmental laws; factories and cities in general are polluting waters and the air; and everyone (you & me) are burning fossil fuels.

We tolerate tyranny because we are weak and look at life with craving expectation. Home Power appeals to people with a need or someone hoping to save money. Very few are concerned about the environment. Selfishness is natural. So in order to implement conservation of fossil fuels, we must apply the law of consequences -- in other words, sell Home Power. Why do we need it? What are we going to get out of it?

Most people even if they have a need do not understand Home Power and so they are afraid of it. They do not know what to buy or how to set it up. Depending on a gasoline powered generator is not the ideal Home Power system.

Maybe we can off-set that by using the method Einstein used in dealing successfully with space problems. And that is to kindle a form of the theory of relatively. We must do whatever we can to change the human mind to one of preservation. Einstein corrected an illusion by changing the point of view. Is it possible to regard Home Power as conservation in a broader perspective and thus effect a similar change of view? Very truly yours, Arthur McCornack, Captain Cook, HI

Dear Home Power Crew,

I have enjoyed your magazine from the start (I still don't know how I got on your mailing list!). Enclosed is a check to help out. Your concept is worth subscribing to. In fact, this subject is the reason I became a mechanical engineer.

My current employment and family concerns dictate that I live in the city within easy commuting distance. However, this serves not to lessen my concern for energy and the environment, but to learn how I, as a grid-connected user, can do better and better. To that end, I make the following observations: A) When buying a refrigerator, be sure it has a condenser mounted on the back for natural convection. The fan power and noise is thereby eliminated. We chose a unit manufactured by Gibson. B) Electric resistance stoves and dryers are silly. Since natural gas prices have dropped, it's being burned to run steam turbine/generators. Thermodynamically, only 43-46% of the energy available in the fuel gets onto the powerline. The electricity user not only pays for the gas, he/she pays for all that expensive (I know; I used to work on steam turbines/generators; a row of blades can get into six figures) power station equipment. Bottom line: burn the gas directly in your house if you live in the city or wherever you have a choice. C) It seems to me that microwaves are worthy of mention as primary cooking devices in an AE (or other conservation-conscious) home. My wife estimates she uses our 1.45Kw unit for 60-90 minutes/day. This covers breakfast, lunch, and at least 1/3 of dinner for four. (Unfortunately, the microwave cannot do all types of cooking.) D) Burning wood is, to me as unconscionable as dumping sludge. Wood burning should be minimized or discouraged, as it produces some nasty pollutants and denudes forests. This is why microwaves running off PV produced DC (or inverter ac) could probably reduce the total impact of a person on the environment. How many people/creatures like to breath other people's smog. E) Propane, while cleaning burning, is also non-renewable and should not be viewed as a panacea to independent living (doesn't it have to be hauled in too?) F) While your magazine focuses on electricity, water and space heating are equal or greater concern and certainly impact the environment. Mention is made in one of the issues of the zero impact of photovoltaics on the environment. GREAT! Now, let's kill two or more birds (utilities) with one stone. It occurred to me that ARCO's photovoltaic glass could be used as the cover sheet for a solar collector. Whatever light is not converted into electricity passes through the glass and is absorbed by the heat transfer fluid in the collector. The heated air or liquid is circulated by the appropriate fan or pump to do useful heating somewhere else. Another fine feature of this low to no impact device is, if it's mounted on your roof, no more valuable real estate need be used. G) Please mention to the do-it-yourselfers not to use solder containing lead in cooper plumping. Lead has lousy effects on children's brains. Please also have used motor oil disposed of properly. Most gas stations act as collection points for re-refiners to pick up the stuff. NEVER pour it on the ground.

In conclusion, I'd like to thank you for your efforts and I hope I've provided some useful thoughts. I'm available for any engineering-type questions from staff or readers. Yours truly, Charles Bright, Kent, WA

Hi!

I read with interest the article in #7 on "Cookin' with Sunshine" because I have been using a solar cooker since 1979! While it is nice to see the fancy & shiny cookers pictured, I wanted the other readers to not get put off thinking that they must first have such a "state-of-the-art" device!

I initially made a parabolic reflector cooker (left most cooker in picture on page 15, HP#7) for my first "test" of solar cooking. This cooker was made out of cardboard and aluminum foil following a pattern in a book called "Solar Science Projects". Yes it did work, but it fell apart from the moisture outside. That's not the only reason I gave up on it... it's use was limiting in that it needed constant attention to keep the focus in the cooking area. It also tended to limit the items cooked to those using higher heats (frying).

Luckily I made another oven, this time the slant faced style. I had seen a box type in an article, but after seeing the 2 slant styles in "action", I decided to make one of those.

Mine consisted of a double plywood box, insulated between with fiberglass, and faced with 2 layers of glass. A hinged back became the door and inside I lined the floor and walls with a thin sheet of aluminum flashing mounted 1 inch away from the surfaces. Everything expect the glass and hinges came from leftovers or scraps and was built with a hammer and a saw by a very inexperienced person! I completed the box with three reflector fins of plywood faced with aluminum foil.

It worked!!! I no longer had to stand over the camping stove to eat something cooked. It also saved time because when my husband and I too our mid-day break from construction (and the HOT sun), our meal was ready. And the best part was that I didn't have to give this oven the constant attention the parabolic cooker needed. The slant style only needed turning about once every 2-3 hours!

I have learned that high temperatures are NOT necessary! My oven gets about 200-250°. This is like a crock pot for cooking, slow and easy, and NO burning! But that doesn't mean that I am limited to stew etc. Baking of almost any item (except bread) can be done if you cut back a bit on the liquid. You will

also need to at least double the time required by a standard recipe. I make (brown) rice in my cooker by putting the water in a lidded ovenware bowl and first letting that water get hot (15-30 minutes). Then I add the rice to slow cook another 2 or so hours. To cook potatoes, I poke them then wrap them in foil and give them at least 3 hours. It is also good to make more potatoes than for one meal and then use the precooked ones for salads or scalloped dishes. Meat cooks tender and juicy too, but I use a thermometer in pork roasts.

Almost all of my cooking in the oven is done in dark metal cookware, either direct or with a glass ovenware insert. Baked items don't get as sticky on the bottom when I put the pans on a cookie cooling rack to allow the heat to circulate better.

The main difference I had to learn was to plan my dinner in the morning so that it could be done when I wanted it to. That effort has paid off because I became free to be available for other things we had going on at our development site. My cooker is showing its age and wear, but I do have a "better" one planned for future "development". Solar cooking is a part of my life that will remain, it isn't a hobby here! Katcha Sanderson, Paicines, CA

I have gone through HOME POWER #2 through #7 and listed the articles on back-country communication systems so far presented. This listing of references should be of service to others. You can print my name. There may be a reference in #1, but I never received that issue. The titles may not be word for word exactly as the article has it. I am more interested in giving the general descriptive name of the communications equipment referred to in the articles. Hence there may be sub-references in the same article. I will also give names mentioned in articles of equipment to be covered the future so as to have pretty much the gamut of communications equipment for remote locations. This is the list: 1) "Back Country Communications", (an introduction to future issues), HP#2, pg. 16 2) "CB, Citizen Band Radio", HP#3, pg. 36-39 3) "Radiotelephone", HP#4, pg. 29-32, Radio Common Carrier, simplex type and Improved Mobile Service, duplex type 4) "Amateur (Ham) Radio", HP#5, pg 31-31 5) "Amateur (Ham) Radio for HOME POWER People", HP#6, pg 34 6) "Radio Links Telephone", HP #7 pg 32-33, Telemobile UHF radiotelephone, to be reported on in HP#8 7) future communications columns, mentioned in HP#3, pg32: More antenna projects, cordless telephone (should cover foreign-made models, which have a longer transmission-receiver distance, say 2-3 miles, than U.S. models and U.S. models), TVs, Satellite TV, FM stereos. I would also suggest: cellular phones, though the above articles say these are urban 2-way radio and transceivers, I am supposing there are other names for the above communication equipment.

We have a hermitage about one and one-half miles into the hills. In my opinion a cordless phone would meet our specifications: 2-3 mile range, able to send and receive outside calls as regular phone, relatively inexpensively. We have a U.S. made cordless phone, but only reaches one thousand feet. It is excellent for that distance. We understand the greater distances of foreign-made models are not yet allowed in the U.S. If you know where such foreign-made cordless phones can be purchased, or someone who reads this letter, please let us know. Very Sincerely, Father Virgil Dusbabek, OCSO, Engineer, Abbey of Our Lady of the Holy Trinity, 1250 South 9500 East, Huntsville, UT 84317

I really appreciate all the info packed into HOME POWER. My wife and I are medical missionaries in Sierra Leone, West Africa and this past term have been using solar panels to generate power for lights in our house. The compound has two diesel generators, but these are only used for about 3 hours in the evening and for surgery days. So the solar lights in our house get alot of use

The address I have given is my parents' address who will then forward it to me. Thank you so much. Keep up the good work. Ron Baker, MD

Dear Home Power

I noticed your request for information on wind power systems. The need for a site survey, before making a decision about installing a wind generator is the focus of my letter.

In 1981-82, I had a Bergy wind machine. My system consisted of a 1000 watt wind generator on an 80 foot tower, and an inverter to pump excess electricity back into the grid.

Norman Oklahoma is on the edge of the great plains, and has average wind speeds of @12-13 mph. However, my machine did not produce much electricity, primarily because the tower was too low. There was too much turbulence at 80 feet, and not enough energy in the wind. (The size of the tower that would fit in my yard was limited because of the small size of my yard.)

Another man had two machines in different parts of Norman. The west side of Norman is flat and almost barren of trees, where as the east side has small rolling hills and is very wooded. As you might expect the machine on the flat side to town outperformed the machine located among the trees.

Based on my experience in Oklahoma, a wind machine needs to be a least 50 feet above surrounding trees, not only to intercept more wind, but to avoid turbulence which can be caused by surrounding trees and buildings. Turbulence causes a wind generator to "hunt" for the wind, and it's speed will vary a lot.

Simply installing a tall tower is not the answer. Flow patterns vary according to the terrain. The speed and direction of wind can vary a great deal within a small area.

This information is not technical or supported by any numbers, but it points out the need for a site survey before installing a wind generator.

HOME POWER has received good reviews in PV NETWORK NEWS and TRANSITIONS recently.

You are doing a good job! John Luker, Norfolk, VA

Hi There POWER Crew

How are things on the ranch? Enjoy your fine magazine. I read it from cover to cover many times. I start watching for the mailman at the earliest possible delivery date.

Richard, I enjoyed your magneto battery conversion. But much of it was Greek to me. All connections need not be electronic. A workable low-tech system would use the 6 volt coil you mentioned, mounted on the coolest place on the engine or on a separate bracket, use an aircraft type single throw double throw center off toggle switch. Connect 12 volts to one end of the switch, tap battery at 6 or 8 volts and connect to the other end. If the tap is not possible, use a resistor of 5 or 6 ohms, 30 watts across the ends of the switch, connect the center switch to one side of the coil. Connect the other side of the coil to the points. If the engine has a kill switch to points, this wire may be disconnected from the switch and connected to the coil. The old coil wire must be disconnected from the points. Leave the points and condenser as they are. If the condenser is bad, it may be disconnected from the points and an auto condenser can be mounted near the coil and its leads connected to the coil post. Flip the switch to 12 volts for easy starting, then lower the voltage to run. I have changed several old Farmall tractors such as a BC and Cubs by unbolting the old coil and snipping the coil wire from the points. Reinstall the old coil for a dust cover. Use the post on the side of the magneto to connect the points to the

coil. The original kill switch is removed and the single pole switch is used to connect a 6 volt battery to the 6 volt coil.

In response to Jake the wind generator man. The Jacobs will run slower and be partly stalled by a 24 volt battery because it will produce 24 volts at a lower speed. It will not be able to rev up to full power. This could be compared to starting your car in second gear. A 12 volt battery like third gear, a 6 volt battery like fourth. A blocking diode would be used between the generator and the battery, where a reverse current relay or cutout was originally used. With the generator running at a speed to produce 30 volts, the battery wire could be removed from the diode without a spark using a 32 volt battery. If 24 volt batteries were touched to the diode it would arc like a welder, if the cut out relay were used it would have to have a 24 volt coil. If you used a 32 volt relay the generator would speed up to 32 volts when the points closed, then they would burn up and probably weld up and the generator speed would drop back to the 24 volt speed. With the points welded the wind stopped, the generator would run as a motor till the battery was dead. This is a large shunt or compound generator comparable to a large aircraft or welding generator. Its field is fully connected at all times, it could be adjusted by removing the brush cover and locating the field lead. This will be a small insulated wire connected to the insulated brush holder. Disconnect from the holder and insert a 10 ohm resistor in the gap. The resistor should be adjustable so it can be fine tuned at the prevailing wind speed. This will change the overall speed power curve, but will make the most of actual conditions.

Whatever happened to Power House Paul? I would like to see more of his generator articles. Please renew my subscription. Best Wishes, Tom Burnett, Fruitvale, TX

You get your wish, Paul's back this issue and will be a regular contributor.

Thank you, gentlemen, *(HEH! What about us gentlewomen. KP)* for putting it all together. You produce a fine publication.

Not all of us were driven to solar by present necessity. I live in a small town with utility power but I also have, so far, 19 ARCO 701's, 32 golf cart batteries ($10.00 each, almost new when the local golf course went to gas powered carts), & a 6kw Dynamote inverter. All this is wired in two systems. A 12 volt and a 48/120-240 volt. Each system has two battery banks. I bought one tracker and made two more.

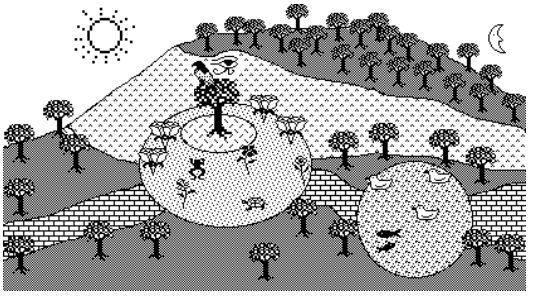
I also built a cord wood greenhouse with yard thick walls. VERY efficient, the sun heats it in the coldest weather. That's about 20° below.

My main heat source for the house is a wood stove that will change when I get the roof rebuilt strong enough to hold collectors.

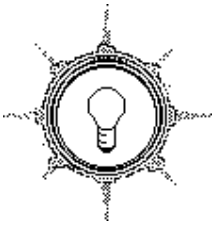
There is a use for solar power that I have not seen you touch on, that is a solar powered forge. I am a blacksmith and a bladesmith. I try to make a living selling damascus steel and knives. For years now I have done all of the yard blacksmithing. That is hinges, hooks, hangers, pokers, door knockers, handles, cookware, strickers and all the tools and decorative iron work. It's low tech and cost effective. Most of the iron can be got for nothing or next to it. Burning fossil fuels (coke coal) bothers me but to work iron you've about got to and I don't use it where I don't have to. Home heating and such.

Also how about an article on hardening a PV system from EMP? I'm one of the odd balls who isn't going to roll over and play dead just because somebody wants to have a nuclear war.

Please stop by if you are ever coming through. You'll be most welcome. Chris Peterson, Aurora, UT



Home Power's Business



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 use Macintosh computers to publish Home Power. 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.

Home Power is published bi-monthly. Ad Deadline for theFeb/Mar 89 issue (HP#9) is 15 Jan 89.

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

International Subscriptions

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

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INTERNATIONAL RATES:

Mexico or Canada: Air- $24. Surface: $21.
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South America (except Columbia and Venezuela), Europe, North Africa: Air- $40. Surface- $23.
Asia, Australia, New Zealand,Pacific Ocean Islands, Africa (other than North Africa), Indian Ocean Islands, & the Middle East- Air $49. Surface $23.

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 would be glad to ship them an extra free copy for forwarding to you. Bulk mailing to Canada or Mexico, write for info.

Home Power Mercantile

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.
See other Mercantile suggestions on page 48.

Back Issues

All back issues are $2 each, while they last.
Shipped in an envelope via first class mail.

Issues 2,3,4,5, 6,7 &8 are currently available. Sorry no more Issue #1s are available.

Home Power Magazine
POB 130, Hornbrook, CA 96044

Micro Ads

These ads are designed for individuals rather than companies. So use your discretion. The rates are 5¢ per character, including spaces & punctuation.

Printing & Distribution Info for HP#8

Copies Printed = 11,000
Copies mailed under labels = 7,294
Copies shipped in bulk = 2,213
Call or write for bulk shipment info.

Home Power MicroAds

Rates: 5¢ per CHARACTER, include spaces & punctuation. $10 minimum per insertion. Please send check with your ad. Your cancelled check is your receipt.

INSTANT DOMES AND GREENHOUSES: 20 minutes set up! 8 to 18 feet diameter. Proven performance and reliability. Many models. Send $1.00 for catalogue. SHELTER SYSTEMS, POBox 67-HP, Aptos, CA. 95001 (408) 662-2821

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ALTERNATIVE ENERGY EQUIPMENT CATALOG. Everything for stand alone power generation, PV's, Hydro-Electric, Wind Generators, Inverters, Water Pumps, Regulators, Refrigeration, Tools, Books, and much more. 92 pages with design guides. $3. US, $6. foreign: WESCO, Box 936-HP, REDWAY, CA 95560

THE ALTERNATIVE LAND ACQUISITION HANDBOOK provides you with 6 Ways to get land FREE or ALMOST FREE! Land Reclamation•Alaskan Homesteading•The Indian Homestead•Mining Claims•Tax Delinquent Land-Lost and•Forgotten Land! Send $20 to Ridgehaven POB 862 Glen Ellen, CA 95442

COMPLETE SOLAR ELECTRIC POWER SYSTEMS. We offer the EchoLite photovoltaic power package: designed to provide modular components for easy installation, secure mounting and quick access. Perfect for remote sites, homes, RV's & marine applications. Free Brochure. Sunwater: 219 Van Ness Ave. Santa Cruz CA 95060 408/423-2429

FREE CATALOG OF 12-VOLT PRODUCTS! Plug into cig. lighter or clip directly to battery. Lantern, Vacuum, Hair Dryer, Chainsaw, Bug Zapper, Drill, Fan, VCR, Fry Pan, Microwave, Refrigerator, Toaster & many more! P.O. Box 664-HP, Holland, PA 18966. 1-215-355-0525

WINCO WINDMILLS: $450 with factory regulator and electronics package, up 1 month, $200 with 10' tower $800. Both. J. Valvano, 25 Doncaster Road, Rochester, NY 14623, 1-716-424-3757

SOVONICS P200 22 WATT PV MODULES: $115. each. Add $5 shipping for individual panels sent anywhere in the lower 48. Buy 2 or more panels and we pay ALL shipping costs. Info: $1. Lake Michigan Wind & Sun, E 3971 Bluebird Rd., Forestville, WI 54213 Phone 414-837-2267

WINDCHARGER 122, 12V, needs prop, stored indoors past 5 yrs. Includes Rohn 10' 25G tower stub w/attached turntable assy. $200.00 plus shipping. David Evans, Box 605, Salado, TX. 76571, 817-947-5493 evenings.

WINCHARGERS, 6, 12, and 32 volt models plus lots of parts. 1500 watt Jacobs $225, generator only. Old 32 volt input ATR inverter $75. Mountain Pass Wind, 711 N "C" St., Livingston, MT 59047. (406) 222-1707.

NORTH WIND L 916 WIND GENERATOR with 100' Rohn tower and utility interface controls, 16kW output into 220v - 3 phase utility grid, or can be modified for DC battery charging. Serious inquiries at: Northern Power Systems, Moretown, VT (802) 496-2955

RECONDITIONED NORTH WIND HR2 WIND GENERATORS, 3kW peak outputs @ 24 and 48 VDC. Serious inquiries at: Northern Power Systems, Moretown, VT (802) 496-2955

DISTRIBUTORS WANTED - MULTI-PURE DRINKING WATER SYSTEMS. This is the right product at the right time. Soaring demand for pure drinking water creates exploding industry. Solid opportunity with high integrity industry leader. Advanced water filters gives pure drinking water for pennies a gallon. Great support network. Full or part time employment. Write or call for free information today. Clean Water Network, POB 272C, Ashland, OR 97520 503-482-2127

12 V - 200 WATT WINCHARGER. Brand new, still in box. This is the older style - with the 10 foot tower. You supply batteries and wire and it's ready. $700.00 plus shipping. Jim Benovic, RT1, Montague, MI 49437 Phone 616-894-6232

LIGHT BULB ADAPTORS convert standard 120 vac lightbulb base to 12 VDC bayonet car bulb socket. Allow use of long-life, efficient, low-cost auto bulbs in 120 vac fixtures. AE-powered home industry. $5 each ppd. Quantity and dealer discounts. NORTHERN LITES, POB 874-HP, Tonasket, WA 98855.

WIND GENERATORS, Towers, Windmills, SOLAR HEATERS, Photovoltaics, MOTORS, Grain Mills, Inverters, Well Pumps, Refrigerators, Waterless Toilets, Tankless & Solar Water Heaters. A limited quantity of ELECTRIC TRACTORS are available from 8 to 16 horsepower. They are cordless, quiet, powerful, rugged, economical. No messy gas to buy. Now you can mow, remove snow, rototill, weld, run power tools using renewable energy. Lots of used equipment. Catalog $3. KANSAS WIND POWER, R 1-HP, Holton, KS 66436. 913-364-4407

32 V WINCHARGER, 1000 watts, good condition. 32 V Delco lightplant, 1000 watts, lots of parts. 1800 rpm cast iron motor. Complete fly ball govenor for Jacobs. Honeywell 12 V rotary inverter, 1500 watts. Call or write for more info. Tom Simko, RT1, Inkom, ID 83245, 208-775-3400

THE SOLAR COOKERY BOOK. Detailed plans and photos for building the best solar oven and the best solar reflector cooker. Plus 100 great, tested recipes for solar cooking. $5.00 postpaid. Dan Halacy, 12761 W. Alameda Dr., Lakewood, CO 80228

SISKIYOU COUNTY HOME OWNERS & BUILDERS: On Tuesday, Dec. 13, 1988 at 2:30 P.M., citizens from around Siskiyou County are petitioning the Board of Supervisors to change our county building codes. We are asking that a committee be formed to draft flexible, safe, simple codes as now adopted in other rural counties & to combine the code changes with a Clean Slate ordinance for existing homes. We urge all interested citizens to attend the Board of Supervisors meeting on Dec., 13, 1988, 2:30 P.M., at the County Courthouse in Yreka, CA. To become more involved contact: Citizens for a Clean Slate, Hurd's Gulch, Fort Jones, CA 96032. or CALL 916-468-5286.

Submission Suggestions

You Want Your Stuff Back ???

If you want your submissions returned, include stamped and self-addressed return shipping materials.

We are not responsible for the fate of any submissions that arrive without such intelligence.

They'll probably hang around until spring cleaning, then go to the dump.

Articles

Write from real experience.

Write clearly, with: short sentences, generous use of subheads, and a straightforward organization of ideas.

Write as if you're talking to intelligent friends.

Cooperative Articles

Maybe you know something, but can't/won't write.

Just give us the info, and we'll write it up for you.

Contact us for further details.

Photographs

We like black and white photos with high contrast and a generous range of rich tonalities.

We want the negative to print from. We'll return it to you when we finish.

Compositions should be simple, filled with large objects.

Illustrations

Black and white art only. No pencils, no ball point, no smeary dreary smudgy wudgy.

Payment

Sorry, we cannot afford to pay anything yet. Be ye rich in spirit.

Editing

We edit all submissions for clarity and fit.

Copyright

You can copyright material in your own name by adding the following line to your first page:

"Copyright (c) 1988 by Your Name"

If you don't copyright the material in your name, we'll copyright it in ours.

If we do that, and you want the copyright back, it's yours.

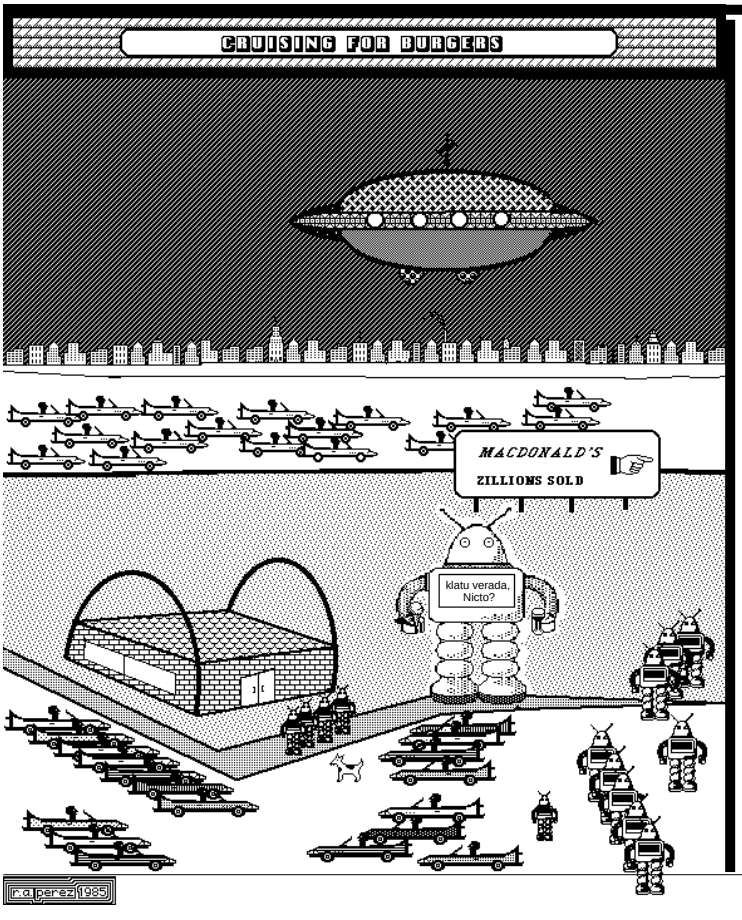
Computerized Submissions

All data is on 400K or 800K Macintosh disks.

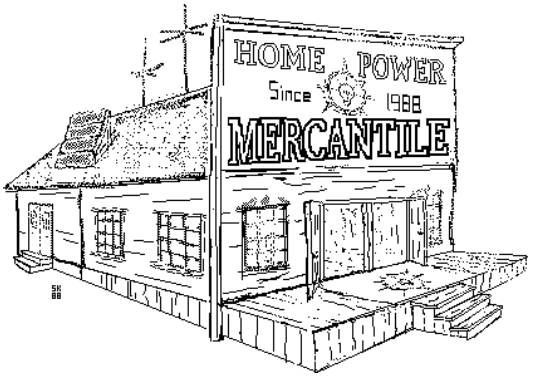
Graphics can be formatted, in order of preference, as SuperPaint, MacDraw, or MacDraft documents.

Text can be formatted, in order of preference, as TEXT, WriteNow, MacWrite, or Word documents.

Spreadsheet data can be be formatted, in order of preference, as Excel 1.5 or Multiplan documents.



Index to Advertisers



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- Sorry, no graphics, no exceptions.
- We will do our best to make your ad look good in the available space.
- If you send us too much copy, you may not like the result.
- Examine other ads for guidance.
- We don't bill Mercantiles, your cancelled check is your receipt.
- Call **916-475-3179** for more information.