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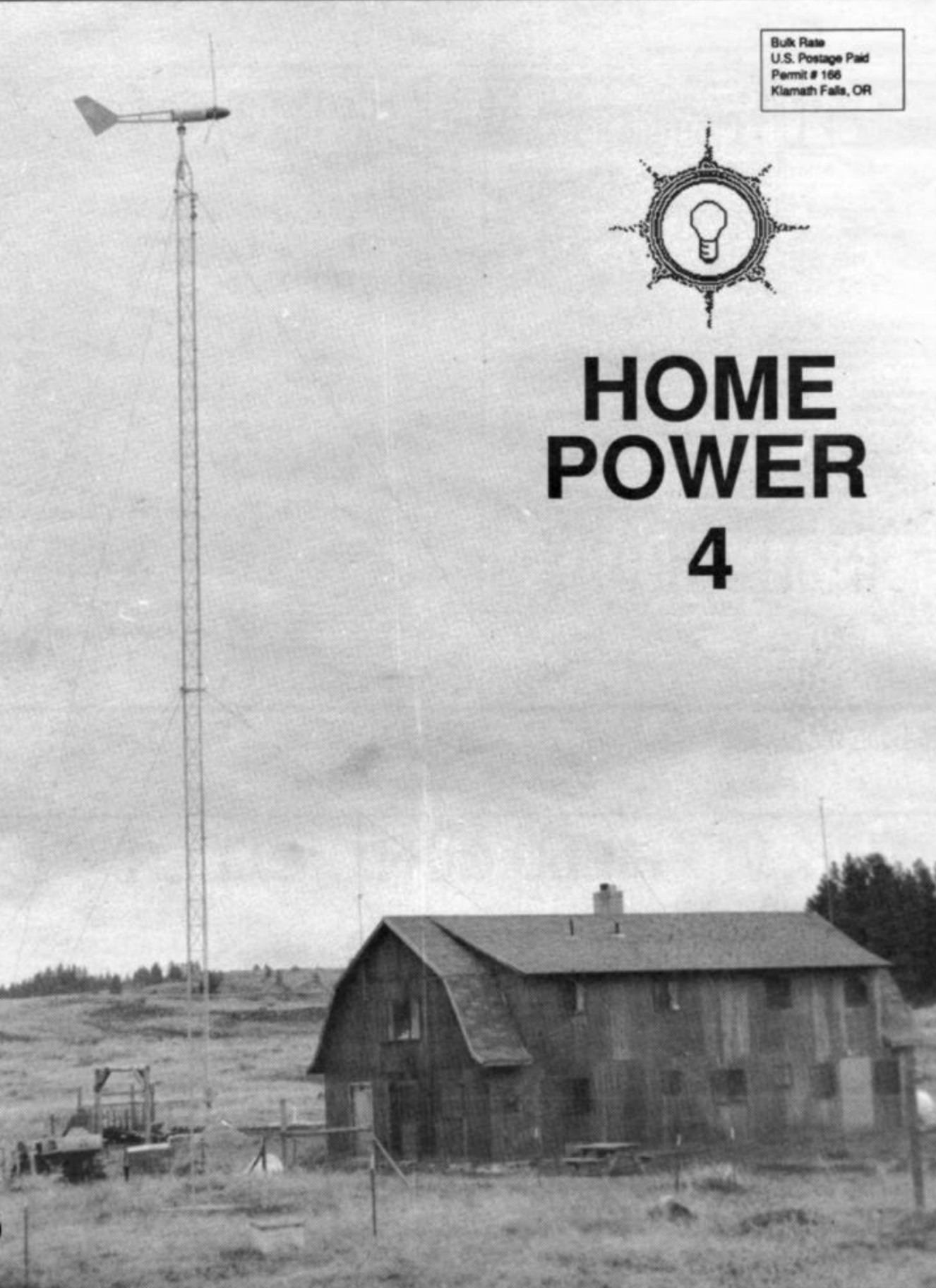

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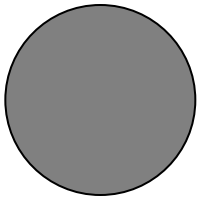

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Home Power

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Contents

Access

Home Power Magazine
POB 130
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Think About It

"Life is like licking honey from a thorn."

Anon.

Cover

Gerald Ames' Wind System in Washington.
Photo by Brian Green

From Us to **You**

One of the first things that you may notice about this copy of Home Power is that it has no date. We try hard to be regularly published, but there are many factors getting in the way of any schedule.

One factor is we must sell enough ads to print and distribute the issue. We're talking paying the printer and the Post Office. Sometimes this happens later rather than sooner. Many thanks to the folks who are supporting us with their ads, especially those who've signed on for long term ads. Your support is giving us the stability and capital to carry on.

Another factor is fatigue. Basically three of us and one full time Macintosh are getting rode hard and put up wet.

So, please excuse us for being a little late. We will try to be more regular and on time in the future.

A Note to International Home Power Readers

If you don't live in the USA and would like to distribute Home Power within your country, please write us. We are sorry to have to charge for international mailing, but that's the way it is. We can, however, ship bundles of Home Power internationally much cheaper than single issues. So, get together, and receive your international copies of Home Power at reduced rates. Write Karen at Home Power for more info.

OOPS!

Corrections to Home Power #3
Page 40-Paragraph 11 which reads, "Resistance in Ωs equals volts x amperes", should read, "Resistance in Ωs equals volts ÷ amperes". Thanks to James M. Byrnes, Anchorage, AK for spotting the error.

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 Macintosh disks.
- Graphics can be formatted, in order of preference, as SuperPaint, MacPaint, or FullPaint 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 or Multiplan documents.

A Working Wind/PV System

Gerald L. Ames

LOCATION OF SITE
My wife Beverly and I live on the western edge of the Colville Indian Reservation in North Central Washington. Our 80 acres lies on the top of a plateau (elev. 2600 feet) with little, but barbed wire to stop the wind. In addition to the wind, we have good solar potential with an average of 4.1 sun hours per day. We have no hydro power potential.

I started thinking seriously about alternative energy around 1965, and moved slowly in that direction until, finally, our home is 100% powered by alternative energy. I looked, briefly into bringing power lines in, but with costs in the neighborhood of $20,000, we figured that we could build a system for less. Paying for access to a power line would give us the privilege of paying a monthly power bill for the rest of our lives. This high cost was our excuse to do what we wanted to do in the first place and that was to produce all of our own power.

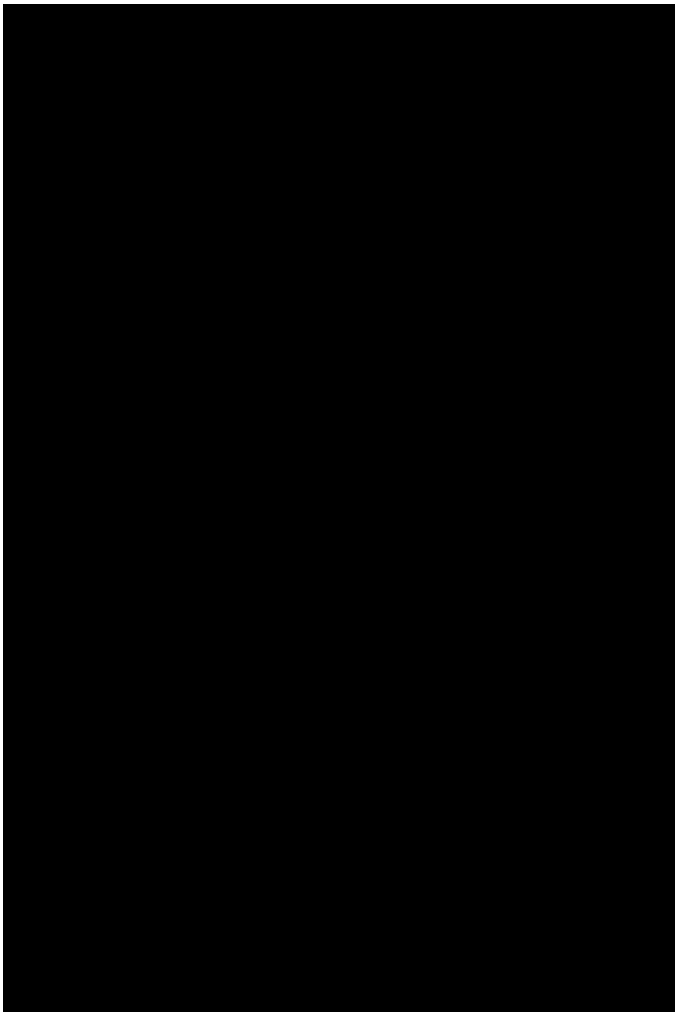
Windpower System
Our primary source of power is a Bergey BWC-1000 windplant which feeds 20 each 6 volt, 250 ampere-hour lead acid, deep cycle golf cart batteries, wired in series to deliver 120 volts DC. This power is used almost exclusively for home lighting, and is an improvement over the kerosene lamps of two years ago. We have a Kohler 110 volt generator for backup but rarely use it, due to the frequent winds. Integrating the 110 volt generator into our 120 volt system required only a slight increase in engine RPM to boost the voltage to within operating limits. One thing to watch for when buying one of the numerous old Kohlers which can be found lying around, is to be sure the generator produces the type of power you need. Kohler built both AC and DC generators and the difference is not readily apparent. The quickest way to tell if it's AC or DC, is to examine the generator section of the unit. If it is DC, it will have 4 field coils, if it is AC, it will have 6 field coils.

The old Kohlers are very durable, since they are built of cast iron and turn only 1,000 to 1,200 RPM. I found ours in the back of an old garage and the owner was glad to take the $250 that I offered to get it out of the way.

The heart of our system, the Bergey BWC-1000, is an up wind, horizontal axis windplant which uses propeller blades that are rigidly attached to the alternator can, but are free to twist about their longitudinal axis. A pitch weight projects forward from the leading edge of each blade. As the RPM increases, the weight tends to twist the fiber glass blade toward a lower pitch angle, thereby improving aerodynamic performance. Bergey employs, what they call an Autofurl™ tail assembly which automatically turns the machine out of the wind, when speed exceeds 32 MPH. In one 23 1/2 hour period, we had average wind speeds of 76 1/2 MPH, with violent gusting, but the BWC-1000 handled it.

The brain of the system is the EMS-4 controller. This unit protects the battery storage system from overcharging or excessive discharge. If the batteries are fully charged, the EMS-4 will automatically divert the power to an alternate load. 5 colored lights on the front of the EMS-4 tell, at a glance, what mode the system is in. Rocker switches allow override of normal switching functions.

The batteries were built especially for our use by Charger Battery Co. of Okanogan, Washington. Though not as heavy or powerful as the Trojan L16W, we did not have to pay the high shipping costs normally associated with batteries, and the entire set of 20 cost only $1270.00. They should last at least 10 years under the conditions that we use them. They are stored in a room inside the house that is dedicated to electrical



The Bergey in its element

gizmos. The temperature is maintained at 70° and daily checks are made on the system. A 5 gallon jug supplies distilled water to maintain the water level in the batteries. A problem of major concern was how to dispose of Hydrogen gas, formed during battery charging. The solution was to put a 3 inch PVC pipe through the outside wall, and each cell is vented to this pipe via plastic tubing, which is placed in a hole drilled in each cell cap. This system works very well.

We never use the batteries below 50% capacity, which after derating by 20%, gives 100 ampere-hours use before recharging is needed. Based on our daily use of 1108 watts, we can go for 10.8 days before 50% discharge is reached. Normally, with the winds that we get, the batteries are recharged, at least partially, each day. We occasionally shut off the generator for a week or so to allow the batteries to cycle, which helps keep them active throughout their full range.

Wind Study

One should never install a system without a study of the winds. We lived at this location for several years before starting the system, and had an opportunity to observe the wind patterns. The wind appeared to blow often enough to charge batteries, provided it was strong enough. We purchased a Model SWE 6010, wind anemometer from Sencenbaugh Wind Electric, and it worked very well. At the end of 1 year, we had the data that was needed to make a decision. The average wind speed from December thru April was 14.0 MPH. This time period was when our electrical load would be the greatest, so it was where the emphasis was placed. Since the BWC-1000 will produce power at 9 MPH, it looked like we had a good location for wind power. Over the last 2 years, we've had to start the Kohler on the average of twice a year, so the system is working efficiently.

Tower Construction

I will, very briefly, discuss the Rohn Tower that supports the wind machine. The tower is an important part of a properly functioning wind system. Bergey Windpower Co. includes an excellent installation manual with their wind machine. It contains plans on laying out guy cable anchors and tower foundation construction that are easy to follow. The tower goes up in 10 foot sections with a gin pole purchased just for that propose. The tower is normally guyed at every 27 feet, but when you have two people climbing on it, the structure sways to the point where it is uncomfortable. We used temporary guy ropes between the permanent cables to stabilize the tower. The 3 ground personnel pulled each section up with a rope and we bolted it in place, then moved the gin pole to the top of that section and started the process again. 60 feet does not sound very high when looking from the ground, but when you are hanging out of a small safety belt, your outlook changes. We put up the tower, including the wind machine, in one day and still had time to consume a few beers.

It is important to place the wind machine in undisturbed air if it is to work efficiently. It is recommended that it be placed at least 30 feet above any obstruction within 300 feet of the tower. There are a number of reports available, which have been written on wind power siting, one of which is found on page 16 of Home Power Magazine #1 written by Larry Elliott.

Photovoltaic System
The second part of our electrical system consists of a set of 6 each, 2 volt industrial cells of 1780 ampere-hours, which were purchased when a telephone company moved its location and replaced them with new cells. These type of batteries are worth looking for and can usually be purchased reasonably. New, they can cost up to $600.00 each, but we got our set of 6 for $645.00. As an example of their longevity, there is a set at Chief Joseph Dam in Bridgeport, Washington, that have been in place for 33 years, and are still in good condition.

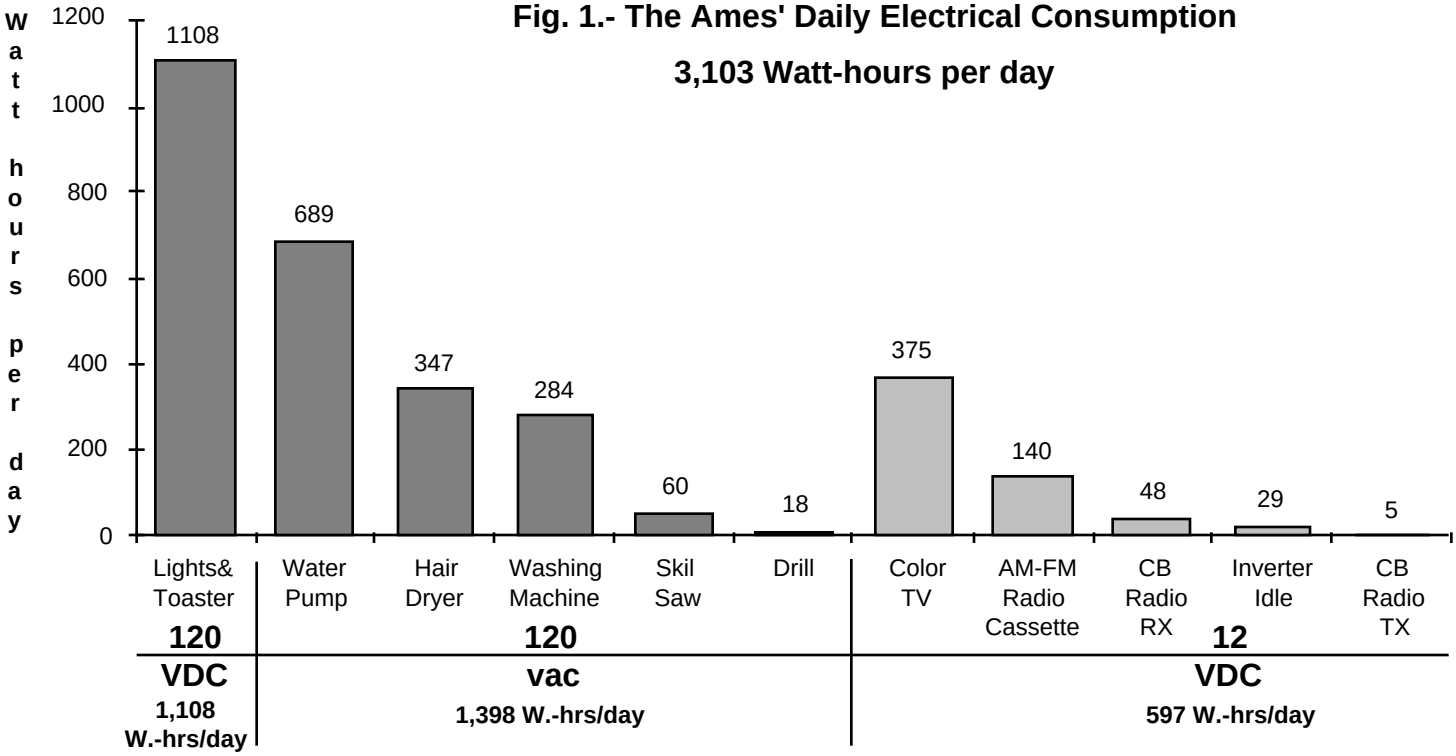
Power Conversion
We are utilizing a Heart Interface inverter, Model HF 12-2000XW, which will handle surge loads up to 5000 watts. This surge capacity is necessary for the heavy starting loads such as automatic washing machines, submersible well pumps, and heavy power tools. Our experience with the Heart inverter is limited since we have just purchased it, but they came with high recommendations & we expect it to function flawlessly.

12 Volt DC Power
12 volt power is being used directly from the batteries for our entertainment center and will soon be used on a Sunfrost F-10 freezer. Presently, we are using 597 watts of 12 volt DC power on electronic equipment which includes a 10 inch Emerson color TV, a Radio Shack Citizen band radio and a Realistic AM-FM radio and cassette player. The only other load at this time is the inverter idle current.

The primary method of charging the 12 volt system is 4 ARCO M-75, 47 watt photovoltaic panels. Future plans call for the addition of 8 panels, installed on a Zomeworks Track Rack.

120 Volt ac Power
The third part of our electrical system is 120 volts AC. The primary power source is a Honda ES-6500, a 6500 watt generator. It presently powers a submersible well pump, automatic washing machine, air compressor, various power tools and small appliances. The ES-6500 automatically slows to an idle when the load is removed, and is very miserly on fuel. It uses 15 gallons of gas per month at a cost of $14.70. Oil and filter changes are accomplished about every 3 months, with costs running about $2.50 per month. This brings the total monthly costs to $17.20 for 20 hours of use, or $0.86 per hour. After the inverter system is fully functional, the ES-6500 will be used only for backup power and heavy loads such as table saws, air compressor, skill saw and heavy power tools. The system is set up so we can quickly switch the ES-6500 in or out of the electrical system. The Heart inverter is similarly isolated by a fused switch.

Explanation Of The System
The rationale behind using 3 voltages was to achieve the best of each system. The reason that we used 120 volt DC, was the ability to use standard code electrical wiring, the capability to use universal appliances and standard 120 volt AC light bulbs. The bulbs do not care whether it is AC or DC power. The system doesn't have the disadvantages of inverter losses



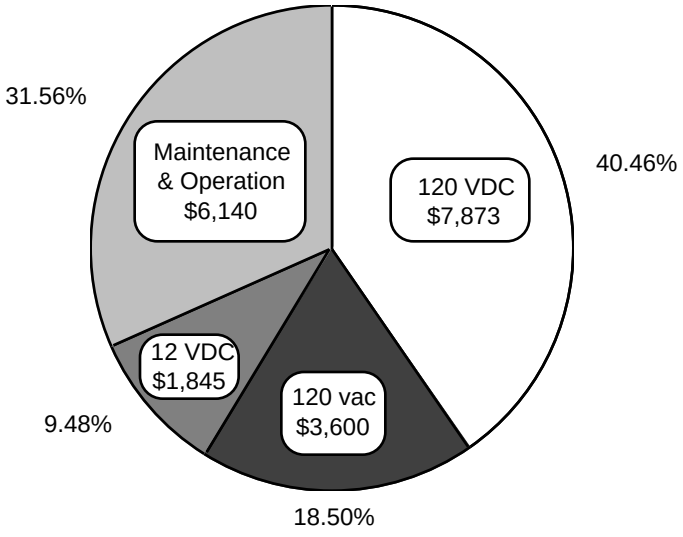
and doesn't require heavy gauge wiring to carry the voltage.

12 volt DC power is very efficient, and there are a lot of electrical products available for it. A freezer of 12 volts will operate on around 800 watts per day, whereas a 120 volt AC unit will consume 3000 watts or more.

The reasoning behind using 120 volts AC is that we, like most everybody else, have a cupboard full of 120 volt AC appliances.

The problem that arises with having 3 different types and/or voltages is the need to have separate wiring systems. This does increase the work and cost, but by catching sales, one can buy reasonably and get good quality. The increased cost is quickly overshadowed by the increased utility. Another problem with separate types of power is that they must be isolated from one another. Precautions must be taken to insure that an appliance of one voltage is not plugged into a different voltage. Our solution was to use 3 different receptacle types. This assures that an appliance can ONLY be plugged into the type of power it needs. The receptacle types and voltages are as follows:
120 volt AC circuit- Levition standard 15 amp, 125 volt duplex receptacle.
120 volt DC circuit- Eagle 1876, 20 amp, 250 volt single outlet receptacle.
12 volt DC circuit- Eagalok 870, 15 amp, 125 volt duplex receptacle.

Fig. 2- Present System Cost Breakdown over a ten year period. $19,458 or $0.58 per kW.-hr.



Gerald L. Ames
POB 749
Okanogan, WA 98840

The Eagle 1876 and Eagalok 870 are polarized receptacles. They allow polarity to be maintained due to the configuration of their bayonet fittings. Correct polarity is absolutely essential in DC systems.

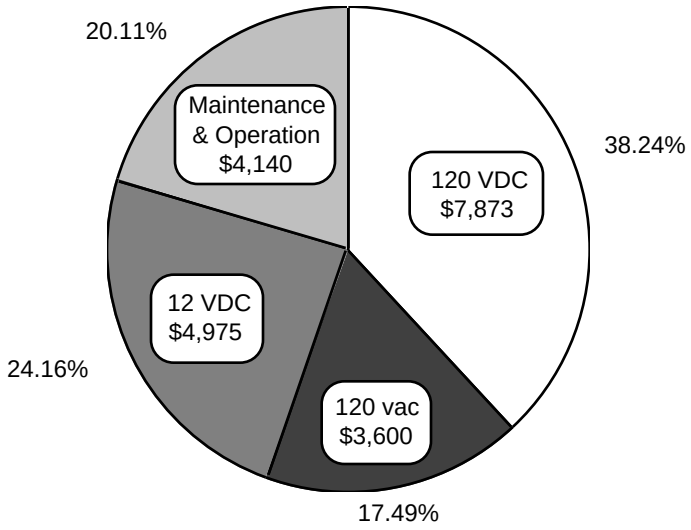
Propane Option
Due to the energy requirements to run ranges, refrigerators and water heaters, we decided to use propane. Costs over the past several years averaged $28. per month. The cost of the propane is very reasonable when compared to electricity.

Home Heating
We have, for several years, used wood for heating. The area has a good quantity of wood available and a considerable amount of time is spent in the the Fall of the year cutting and hauling firewood. It is our cheapest form of heating and is a most satisfying type of heat. One room in our house is used strictly for wood storage and will hold 10 cords (1,280 cubic feet). When wood is stored inside, its BTU output is increased, and it beats going outside in sub zero weather to haul in wood.

We use a barrel stove made of 2@ 55 gallon drums. We purchased a stove kit from Sotz Inc. and installed a catalytic converter so we could burn wood cleanly and efficiently. It does not take a great deal of time to build this stove if one has a normal amount of patience. The stove keeps our 3,000 square foot house warm, and we sleep with our bedroom window open the year around.

Windup
This is our system in a nutshell and I realize that this brief overview of a complex system may pose more questions than it answers. If you have questions about specific parts of the system, or if I can help you in any way, please feel free to write. Please send a stamped, self addressed envelope. I will do my best to help you over some of the rough spots that you will surely encounter. At least, I will tell you how we did it.

Fig. 3- Future System Cost Breakdown over a ten year period $20,588 or $0.61 per kW.-hr.



Access: the Ames's System Component Sources

BWC-1000 Wind gen.- $3155.
Bergey Windpower Co., Inc.
2001 Priestly Avenue
Norman, OK 73069
405-364-1593

Recording Anemometer- $185.
Sencenbaugh Wind Electric
POB 60174
Palo Alto, CA 94306
415-964-1593

12 VDC Freezer, 10 cu ft, F-10. -$1,605.00
Sun Frost
POB 1101, Dept. HP
Arcata, CA 95521
707-822-9095

2kW. Inverter -$1,500.
Heart Interface Corp.
811 1st Avenue
Kent, WA 98032
206-859-0640

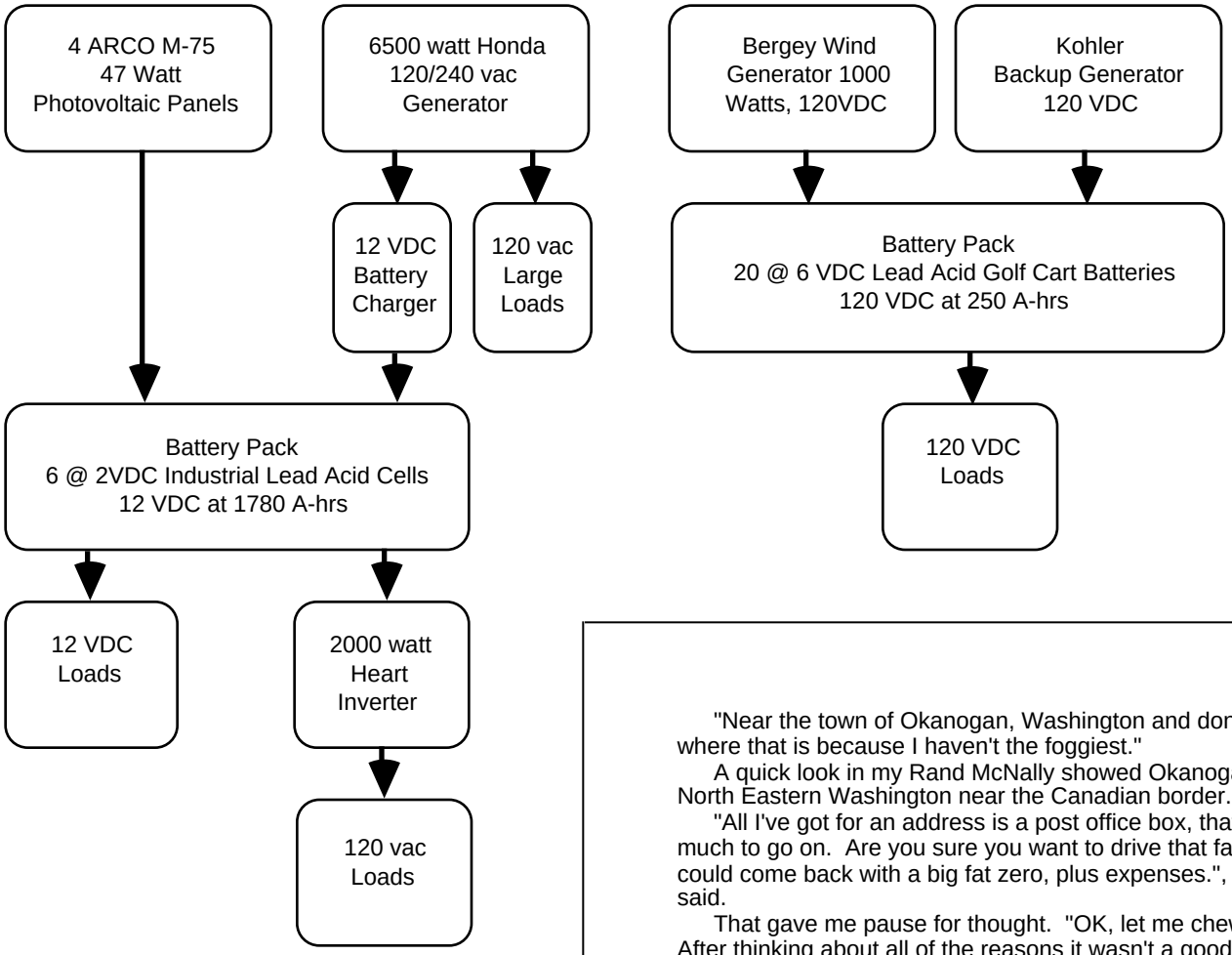
Consol Propane Refrigerator $900.
Pacific Gas Equipment Co.
8451 Gerber Road
Sacramento, CA 95828
916-682-2151

120 vac Gen.,6.5kW.- $2,100.
Wenatchee Honda
314 S. Wenatchee Avenue
Wenatchee, WA 98801
509-633-0075

120 VDC Gen.- $250. (used)
Kohler Electric Plants
Kohler, WI 53044
414-565-3381

Tower, 60 foot- $1,741.25
UNR- Rohn
Div. of UNR Industries, Inc.
POB 609
Frankfort, IN 46041

Ames Alternative Energy Electrical System



A Picture Is Worth A Thousand Miles.

Brian Green

It all started on Wednesday 3 March 1988. Rich gave me a call on the radio to tell me about a great story he had received from Gerald & Beverly Ames. Of course my first question was "Did they send any pictures?"

"No" replied Rich, "and it's to bad too because this would make a nice lead story and cover."

"Well, I've got a few days free, why don't I see what I can get? By the way, Rich, where do they live?", I asked.

"Near the town of Okanogan, Washington and don't ask where that is because I haven't the foggiest."

A quick look in my Rand McNally showed Okanogan is in North Eastern Washington near the Canadian border.

"All I've got for an address is a post office box, that's not much to go on. Are you sure you want to drive that far, you could come back with a big fat zero, plus expenses.", Rich said.

That gave me pause for thought. "OK, let me chew on it." After thinking about all of the reasons it wasn't a good idea I kept coming back to my first reaction, IT FEELS GOOD!

Thursday morning I gave Rich a call and told him, "I'm going for it."

"Are you sure you want to do it? The only other information I have is where he bought his batteries in Okanogan and that's it."

"Yea, I hear ya, but it still feels good besides it could turn a real good story into a cover story."

"All I can say Bri is you've got the heart of a gun fighter, Good Luck and drive safe, stay in touch via land line."

THUS, Began **THE QUEST**

By noon the Chevy was loaded (Yup, it's still the '62 Belair 6 that I bought in Oakland, Labor Day, 1974 for $280.00...see HP#2 pg. 16) and I headed up U.S. 97 North of Weed, California. Rich and Dave kept me company on the VHF 2 meter radio till I was well North of Klamath Falls, Oregon. I hit Yakima, Washington around 9:30 PM, got lost, went 50 miles in the wrong direction and decided to call it a night. Is this any way to run a quest?

Back on the road at 8:30 AM, eyes bright and tail bushed, I headed North. Very pretty drive. I crossed the bridge into Okanogan at 1:00 PM and headed for the Post Office. Six or seven blocks down I spotted the Post Office, a large beautiful old building. Once inside, I asked the Post Master if he knew

where I could find Gerald & Beverly Ames.

"No problem," the Post Master replied "Bev works at the North end of town in that big government building."

Well, next thing I knew I was talking to Mrs. Ames. I introduced myself and asked if it would be OK to take some pictures for Home Power.

"Sure, Jerry would love to show you his system.", Bev replied.

"OK Great, I'll meet you here after work and follow you home." Don't you just love it when a plan comes together! Time to get a motel, shower, food and give the crew a call.

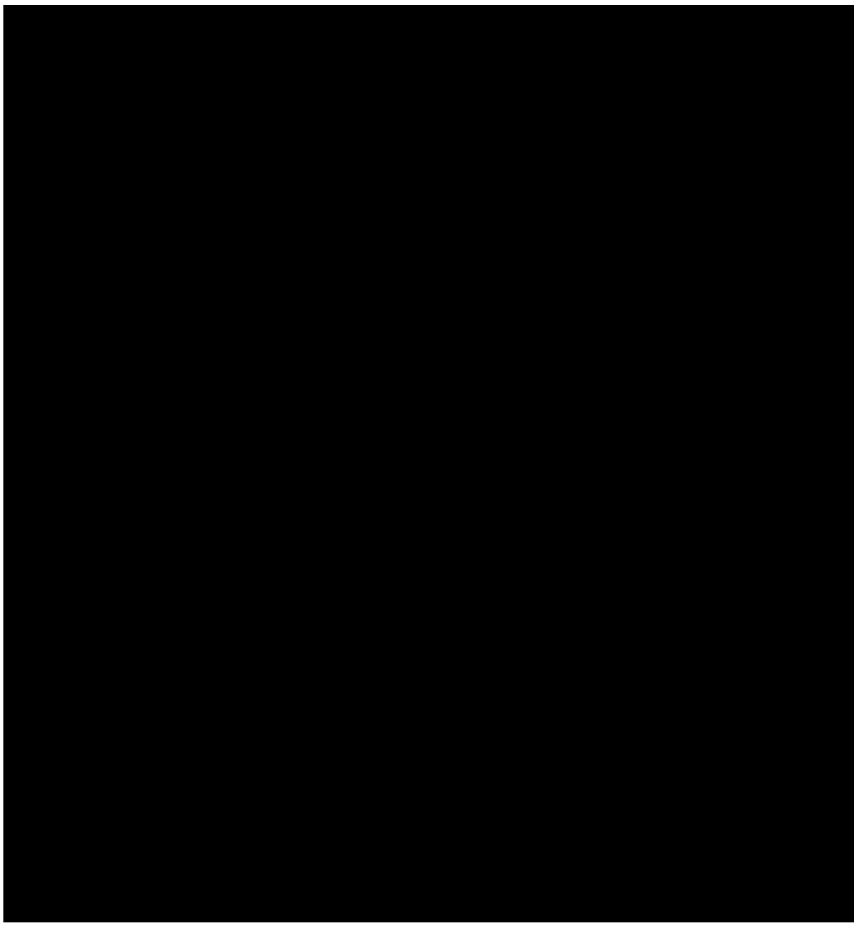
The first thing I saw when I arrived was the Bergey, on its 60 foot tower. Behind the Bergey was the house, which started out life as a barn. We went up the stairs to meet the gentleman that put it all together. After a cup of coffee, I got the "cooks tour". There's only one word to describe Jerry's system and that's "Sanitary". The system is well laid out with lots of attention to detail! Ya done good Jerry.

The next day was heavily overcast and spitting snow. We decided to shoot the outside pictures before the weather got any worse. After a very nice lunch, Jerry and I went downstairs to take pictures of the Battery Room. Jerry has the downstairs well organized, with room for wood, wood stove, shop, batteries & engines, and home canned goods. After warm hugs Goodbye, I pointed the Chevy South and headed for home.

A special Thanks to Bev and Jerry for opening their hearts and home to a total stranger. It was nice to share with you. ***Brian***

I drove 1,591 miles, got 19.3 MPG, used 1 quart of oil, spent approximately 32 hours driving, ate 10 road burgers and drank a gallon of coffee.

Many thanks to Brian Green for his initiative, determination and courage. He made the trip to get these photos with no encouragement from the rest of us, and he did it with his own money (HP is broke as usual)! With folks like Bri working with us, Home Power is bound to succeed and please. Rich



The Complete Battery Book

by Richard Perez

Essential Information for Battery Users & AE People.

Covers 15 types- inc. Lead-Acid & Ni-Cads.
Many details on applying batteries in home power systems.
186 pgs. softcover. $19.45, postpaid in USA, from:

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Post Office Box 442, Medford, OR 97501
tele: 916-475-3179

Selecting System Voltage

Windy Dankoff

The independent power system is based on storage batteries and direct current (DC) electric power. Batteries are low voltage modules that may be assembled in 6, 12, 24 volt or higher configurations. Voltage is the electrical "pressure" at which the system operates, and part of the battery's job is to maintain this pressure at a fairly constant level. Thus, a "12 volt" battery maintains a working voltage within the range of about 11 to 14.5 volts-- a STANDARD. A 12 volt appliance will run properly within this range of electrical pressure.

While the voltage remains fairly constant, the CURRENT (measured in AMPS) varies according to the power required by the appliance. As more lights are turned on in your house, more current is drawn from your batteries. A large bulb draws more current than a small one. Some appliances draw different amounts of current at different times; a circular saw draws more current cutting 2" wood than 1/2" wood because the motor works harder.

12 volts is the most common standard for alternative energy homes only because it is already a conventional standard-- for vehicles! As we progress to higher voltages, less current (amps) is required to deliver the same amount of power (watts/horsepower). Wire, switches and other in-line components are sized according to the CURRENT they carry; the voltage has little bearing on their sizing. Therefore, a 24 volt home electric system is less costly to wire-- it requires half the wire size, and less labor to install. Control systems and inverters contain components that the current must pass through, so they too can be smaller and less expensive in a higher voltage system.

To confirm this for yourself, compare prices of 12 and 24 volt charge controllers and inverters. The 24 volt models handle far more watts per dollar! Efficiencies also tend to increase with higher voltage/lower current. To see an extreme example of relative wire sizes, look under the hood of your car and see the BIG wire that goes from the battery to the starter. A typical circular saw requires as much power as your starter, but look at the LITTLE wire it uses! The saw uses 120 volts, and requires 1/10 the wire size to carry 1/10 the current.

The common voltage standards for independent-powered homes are 12 VOLTS and 24 VOLTS. Your choice of standard is based on these factors:

(1) OVERALL SYSTEM SIZE: Small, cabin-size systems standardize on 12 volts, which offers the widest choice of small DC appliances and small inverters. Medium to large homes generally cost less to set up on 24 volts, for the reasons below.

(2) INVERTER SIZE: Inverter requirements beyond 2,000 watts or so indicate 24 volts, for lower cost per watt and higher efficiency.

(3) DC WELL PUMP OR OTHER LARGE MOTORS: Motors above 1/4 HP often necessitate use of 24 volts, whether they are DC motors or AC run by inverter. Large motors are more efficient at higher voltages. High current is required to start most motors so both wire and inverter need to be oversized. So, the potential savings are especially great in going to higher voltage for motor circuits.

(4) WIRING DISTANCES: Long wire runs from PV or (especially) wind or hydro generator, to a DC well pump, or to other buildings can be very costly at low voltage/high current. The longer the distance, the larger the wire must be to reduce losses. So, cutting the current in half by using twice the voltage can cut your wire cost by nearly 75%!

(5) PLANS FOR FUTURE GROWTH: If any of the above indicate a requirement for 24 volts in the FUTURE, set up for it from the start so you won't be left with obsolete equipment. If you see a need for higher DC voltage, consult your dealer.

Voltage converters are available for running 12 volt equipment (such as electronics) on a 24 volt system. High quality 24 volt lights are nearly as common as 12. Many large DC motors and pumps are not available at all in 12 volts, because the lower voltage motors are less efficient and require costly, over-sized wire, breakers and switches.

We do not go to 48 volts very often because we cannot get DC lights, refrigerators and well pumps at that voltage. Most PV dealers and users agree that DC power still has its place for running the specialized, super-efficient DC appliances made specifically for independent power. Direct use of DC in well-engineered appliances reduces both energy consumption and inverter requirements.

We are maintaining 12 and 24 volts as our DC home standard because it is safer and less costly to use than higher DC voltages. (1) Less battery cells are required (they are 2 volts each) with less connections between them. (2) High DC voltage from batteries (120 volts) poses a serious shock hazard (twice that of 120 volts AC) and (3) high DC voltage poses more fire hazard (it causes much bigger sparks) than AC power at the same voltage. Low voltage virtually eliminates these hazards. 120 volt DC is used in industrial power systems, but generally not in homes. Our use of high-efficiency appliances and our elimination of electric heating devices keeps power consumption low so wire sizes in

our DC homes need NOT be 5 or 10 times oversized for low voltage!

A system dedicated to one specialized purpose need NOT conform to the common 12 or 24 volt standard. When a solar system is designed only to power a well pump (with a motor in the range of 1/2 to 1 HP) we may go to 60 or 120 volts DC if that optimizes economy and efficiency.

Remember, the final product of your energy system is not volts-- it's light, water, communication, mechanical energy, etc. The voltage selected should be that which produces these ends at the lowest overall cost, with a high degree of safety and reliability.

Windy Dankoff is the owner of FLOWLIGHT SOLAR POWER and FLOWLIGHT SOLAR PUMPS, PO Box 548, Santa Cruz, NM 87567

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the Wizard Speaks

So what's stopping forward progress? Why is there a new energy crisis all the time?

That's easy. It's because of the three bigs. That's three bigs, not pigs - or is it big pigs? These are big business, big government, and big labor. The three bigs have a vested interest in the status quo.

Big business is easy. Nor energy crisis - no big profits. No energy crisis - no new toys (nuclear plants, etc.). Wow, the executives are out of a job; the banks are worried; is this the end? HA! HA!

Big labors vested interest is of course in jobs. Less jobs mean less union dues, less union political power, and less money and influence for union bosses. The possibility that there may be more jobs over all does not interest them. Of course not!

That leaves the last big, big government. Big government needs the energy crisis. It needs the false idea of international conflict over energy to flex its military , economic and political muscles overseas. It uses the same crisis to stir up people at home with false patriotism and bring about economic, social, and political changes for the furtherment of its own ideals of big government at the expense of all else.

To deal with the three bigs we must develop exsisting renewable energy technologies. We must investagate promising edge level processes. We must discover new physical and biological systems for energy generation. the free lunch is around the corner. Let's turn that corner.

Nickel-Cadmium Batteries

Richard Perez

This begins a series of articles about nickel-cadmium (nicad) batteries. From small sealed nicads for portable use to large vented wet nicad cells for stationary storage, we're going to cover it all. There are different types of nicads, each with its own operating characteristics and applications. This is about the small nicads used in portable electrical gear. These rechargeable wonders are a good and inexpensive place to begin learning nicad technology.

So why do I need to know about nicads?
Well, if you now use any type of portable electrical equipment and nonrechargeable (disposable) batteries, then these nicad wonders can save you a pile of money. The use of rechargeable batteries not only makes economical sense, but environmental sense also. Imagine the material, time and energy that go into making a battery. We use it once, and then it becomes a disposal problem-- an environmental liability.

Ask yourself how many AA, C or D sized flashlight batteries you have purchased over the years. Just about everyone, home power or grid person, uses flashlights, portable radios, pack around stereos, and myriad other battery eating portable gear. The nicad offers you the ability to recharge these batteries. This saves money and trips to town. In the case of home power types, we get to refill our small nicads from our larger AE systems. So instead of paying again and again for disposable batteries, we can refill our nicads using the sun, wind and water.

Let's warm up on some basic nicad chemistry before getting on to the wonders that can be accomplished by inviting the small nicads into our lives and flashlights. This chemical data applies to all types of nicads, so whether you put a small cell in a flashlight or use the larger cells for home energy storage, this information is valid.

The Nickel Cadmium Reaction
Most of us are familiar with the lead acid reaction that stores energy in our systems. The nickel cadmium reaction is similar. It uses chemical bonding to store electricity just like the lead acid system. The major difference between these two battery types is that the nicad uses an alkaline chemical reaction rather than an acid one. The lead acid system uses an acid electrolyte, while the nicad system's electrolyte is a base.

The anode (the positive pole of the cell) of a nicad is composed of nickel (Ni) and nickel oxide hydroxide (NiO[OH]). The cathode (the negative pole) of the nicad cell is made from cadmium (Cd). The electrolyte, which is a paste in the small portable cells, is a 25% to 35% solution of potassium hydroxide (KOH) in water. The chemical reaction is a basic oxidation and reduction type (REDOX). For those who speak chemistry the charge/discharge equation is below.
In a lead acid system, the electrolyte actually participates in the cell's chemical reaction. When the lead acid battery is fully charged, its electrolyte contains about 35% sulphuric acid. When the lead acid battery is fully discharged, the electrolyte is only about 7% sulphuric acid. This change in the electrolyte makes it possible to determine the state of charge by measuring the specific gravity of the lead acid battery's

$$Cd + 2Ni(OH) + 2H_20 \underset{\text{discharge}}{\overset{\text{charge}}{\rightleftharpoons}} Cd(OH)_2 + 2\,NI(OH)_2$$

electrolyte. Such is NOT the case with the nicad.

The nicad's electrolyte does not participate in the cell's chemical reaction. It remains a 25 to 35% solution of potassium hydroxide regardless of the nicad cell's state of charge. The electrolyte acts as a medium for ion and electron transfer, and does not enter into chemical changes with the anode or the cathode.

The lead acid reaction produces a potential difference of about 2 volts per cell. The nicad reaction is slightly less energetic and produces about 1.2 volts per cell. While a 12 VDC battery pack can be constructed of six series cells in a lead acid system, the nicad system requires 10 series cells to reach a potential of 12 VDC.

Nicad Physical Construction
There are two basic physical types of nicad cells. One is called "sintered plate" and the other "pocket plate". While these two types use the same chemical reactions to store energy, they differ in physical construction and performance characteristics. This article will consider the sintered plate nicads. The sintered plate technology is employed in the manufacture of the smaller cells used in portable equipment. The pocket plate technology is used in the larger cells applied in more massive, stationary storage, and will be covered in future articles.

The sintered plate nicad is constructed of nickel support plates impregnated with the active materials in powdered form. Hence their name "sintered" meaning powdered. The use of powdered materials allows for easy and inexpensive manufacturing. A powder has a large surface area in relation to its mass. Powdered reactants give the sintered nicad large

internal surface areas for chemical reaction and results in a cell with very low internal resistance.

The internal resistance of a battery is a critical factor in its operation. Internal resistance affects the ability of the electrochemical cell to deliver current. High internal resistance makes a cell unable to deliver large amounts of current in short periods of time. High internal resistance also makes the voltage of the cell drop radically as it is loaded. In any battery, low internal resistance is a highly desirable characteristic. Low internal resistance means that the voltage of the cell will remain high eventhough it is heavily loaded. Even very small sintered plate nicads are capable of delivering very large amounts of current for short periods of time. This is why they work so well in high drain applications like motorized toys, drills, video cameras, and other applications requiring short duration, high current.

Nicad Package Size	Cell Capacity in Ampere-hours	Standard Charge Rate in mA. for 15 hrs.	Cell Type	Cost per Single Cell
AA	0.500	50	S	$2.60
AA	0.500	50	R	$2.75
AA	0.500	50	H	$2.70
AA	0.600	60	E	$2.85
C	1.650	180	R	$6.70
C	1.800	180	H	$6.10
C	2.000	200	E	$7.35
D	4.000	400	S	$11.30
D	4.400	440	E	$12.90

Type Code: S = Standard, R = Rapid Charge, H = High Temp., E = Extra Capacity

Fig. 2

The steel cased sintered plate nicad is made in a variety of sizes that correspond to the packages of regular nonrechargeable batteries. The most commonly used nicad packages are the AA, C, and D sizes. In physical dimensions, the sintered nicads are identical to the flashlight batteries of the same package. In most applications, their lower internal resistance allows their use as direct replacement for the zinc-carbon or alkaline (zinc- manganese dioxide) cells eventhough the nicads have slightly less voltage per cell. While the nonrechargeable types have voltages of about 1.5 volts per cell, they also have much higher internal resistance than the nicad. This means that under load the nonrechargeable types' voltage drops to about the same level as the nicad's under operation.

Sintered Plate Nicad Capacities

Figure 2 details the electrical capacity (ampere-hours) of a variety of standard nicad packages. This figure contains information relating the nicad's package size to its electrical capacity, recharge rates, and cost. Let's just consider the capacity of the cells first. Note that there are several types of nicads made for each cell package size, more on this later.

The capacity (in ampere-hours) of a standard nicad package is about 1/2 that of a nonrechargeable alkaline (zinc-magnesium dioxide) cell of the same package size. This means that when you replace a nonrechargeable type with a nicad you are trading capacity for rechargeability.

A note of caution and BEWARE. Some manufacturers are making a D sized nicad that is really nothing but a C sized nicad masquerading in a D sized package. This is the honest truth and based on personal investigation. I found a D sized nicad being offered at a very cheap price. I bought two and found that inside the D sized case, there lurked a C sized battery. It took a hack saw to discover the truth of the matter. So if you're buying nicads, be sure to check the capacity of the batteries you are purchasing with the table in Figure 2. If the capacity of the batteries you are considering is much below (>15% below) that listed on the table, then beware, you are being conned on the basis of price.

There are four types of nicads listed in Figure 2, standard (S), rapid charge (R), high temperature (H), and extra capacity (E). These names are pretty much self explanatory. The rapid charge nicads can be filled at C/4 to C/5 rates without damage. Note that rapid charge models are only available in the smaller sizes. This is because the larger packages have trouble getting rid of the heat that results from rapid recharging. High temperature nicads are made for operation in temperature environments between -20°C. and 70°C., while standard models operate from -20°C. to 50°C. The extra capacity nicads have about 10% greater capacity than the standard models in the same package size.

The prices listed for nicads in Figure 2 are strictly average. By shopping around you may be able to get quality batteries for as much as 30% less than the prices shown. We have had very good luck recycling surplus and used nicads. Our success rate for bringing these "dead" nicads back to life is over 90%. The techniques for rejuvenating tired nicads will be in next month's article on batteries.

Discharging Nicads

This is simple, just use them in place of a nonrechargeable battery. The low internal resistance of the nicad causes its voltage to be very constant over the entire discharge cycle.

This is disconcerting for first time nicad users. For example, when we use regular batteries in a flashlight we are used to the flashlight dimming long before the batteries are completely discharged. This dimming is due to the voltage of the regular flashlight battery dropping radically as it discharges. Nicads don't do this; their voltage remains fairly constant. This means that the flashlight doesn't dim as the nicads approach empty; it suddenly goes out as the nicads run dry. This characteristic will be noticed with all appliances powered by nicads. They will work at a constant level until the nicads suddenly poop out.

The relatively constant discharge voltage of the nicads makes it very difficult to determine their state of charge by measuring their voltage. In fact, the temperature of the nicad cell has a greater affect on its voltage than its state of charge. In general, consider that a nicad is fully discharged when its voltage, under load, falls below 1.0 VDC. This 1.0 VDC level is called the nicad's "discharge cutoff voltage".

A fully recharged and rested (for at least 6 hours after recharging) nicad will have an open circuit voltage of between 1.28 and 1.33 VDC. The differences in voltage between a full and an empty nicad are in the tenths of a volt. In order to make any meaningful voltage measurement of the nicad cell, an accurate digital meter with resolution in the hundredths of a volt is necessary. Individual cells from differing manufacturers will exhibit differing absolute values of voltage. Some are hotter than others. Measure the performance of the particular cells you are using to determine the exact voltage values for those particular cells.

We usually just run our nicads until they are completely discharged, and then recharge them immediately. Leaving nicads to languish in a discharged state is sucking around for problems. While discharged, nicads seem to have a polarity identification crisis, they may reverse their polarity. More on this and other nicad esoterica in future articles.

Nicad Longevity
Well, the reason we are considering nicads is that we can refill them when they run dry. So how many times is it possible to refill the nicad? The answer is somewhere between 200 and 1,000 times. The actual number of cycles the nicad will deliver depends on two factors: the quality of the cell's manufacture and how the cell is recharged. It is the recharging of the nicad need our consideration.

Recharging Small Sintered Plate Nicads
The manufacturer of the nicad cell will be more than happy to sell you a charger to refill the cell. Avoid this charger like the plague. The recharging units supplied by most commercial manufacturers are designed for unattended and unintelligent recharging of the cells. It is the primary reason why most folks get only 200 refills from their nicads, rather than the 500 to 1,000 cycles possible. Ponder the manufacturer's point of view, if your nicads only last 200 cycles, then he gets to sell you some more batteries.

These factory made nicad rechargers are usually powered by 120 vac. You plug them into the wall receptacle, insert the nicad in them, and come back an unspecified amount of time later to a supposedly refilled battery. Well, the fact of the matter is that in order to keep you from forgetting the battery and overcharging it (which could destroy the battery), the charger is designed not to be able to completely refill the nicads. So most factory made nicad chargers sacrifice cycle life or easy (on the user's memory) recharging.

If you are powering the factory 120 vac charger with inverter supplied electricity, then the situation is even worse. The lower PEP voltage and lower ac waveform power content of most modified sine wave inverters makes the factory charger work even more poorly. The net result is that the small nicad never gets really full, gradually loses it capacity, and fails prematurely. But cheer up, we can recharge these batteries quite effectively using the DC power available in our home power system. All that is required is a little effort and attention to the process.

Recharging Nicads using DC
It is possible to recharge small nicads directly from the large lead acid batteries in the main system. All that is necessary is to limit the amount of current flowing through the nicad, and to limit the amount of time that the nicad is under charge. What follows here is the strict basics for recharging nicads. There are many more methods and machines to do this job that aren't in this particular article. Let's get the basics first, then we'll get fancy.

The actual amount of recharging current that a nicad requires depends on its capacity. The best overall rate to recharge small nicads is the C/10 rate. This means the capacity of the battery, expressed in ampere-hours, divided by 10. For example consider a AA nicad with a capacity of 0.5 ampere-hours (500 milliampere-hours). Its capacity divided by ten is 0.05 amperes or 50 mA. This C/10 charge rate is applied to the battery for a period of 15 hours. At the end of this time, the battery is refilled. Figure 2 shows the C/10 rate for a variety of small nicads.
Note that the battery is recharged for 15 hours at a C/10 rate. This is a 50% overcharge of the nicad. This overcharge assures that the nicad battery is totally full. There is no danger in this time-limited overcharge because it is current controlled.

Nicads are rarely recharged as single cells. They are most commonly used and recharged in packs, or combinations of cells either series or parallel wired. Nicads are assembled into packs in exactly the same manner as any other battery. See Home Power #1 for details on the series and parallel use of batteries.

Figure 3 is a schematic for recharging nicads from a larger lead acid battery. The 12 VDC lead acid battery provides the charging energy. The charging current, into the nicad(s), is limited by the resistance provided by the rheostat. A rheostat is an adjustable power resistor. The ammeter measures the amount of current flowing into the small nicad(s) under charge. The voltmeter measures the voltage of the nicad(s) as they recharge.

This circuit can be used to recharge a single small nicad battery. It can also be used to simultaneously recharge packs of nicads. Using a 12 VDC battery we can effectively recharge up to 6 nicad cells in series, and an unlimited number in parallel. If you are recharging nicads in parallel, use the capacity of the pack to determine the C/10 rate. The 100 Ω rheostat is effective for all nicads from AA to D sized. The 10 watt rating of the rheostat assures that it will last and not die from overheating. One source of such a rheostat is Allied Electronics, 401 East 8th Street, Fort Worth, TX 76102, or call 1-800-433-5700. Their stock number for this rheostat is 875-4012 and the cost is $11.28. Their minimum order is $25,

so get together with others and order a couple at a time. Users of 24 volt systems can also use the circuit shown in Figure 3. If you have a 24 VDC battery, then double the resistance of the rheostat to 200Ω.

The advantages of using a resistor to limit charge current are simplicity and cost. It's easy and cheap. There are, however, some disadvantages to this setup. The voltage of the recharging process is not limited. If the DC voltage of the main system's lead acid battery were to rise, as when it's charged, the current flowing into the nicads will also rise. The lack of voltage limitation in this process can lead to a loss of current regulation. The resistor is also not very efficient. We are controlling current into the nicads by wasting the excess energy as heat.

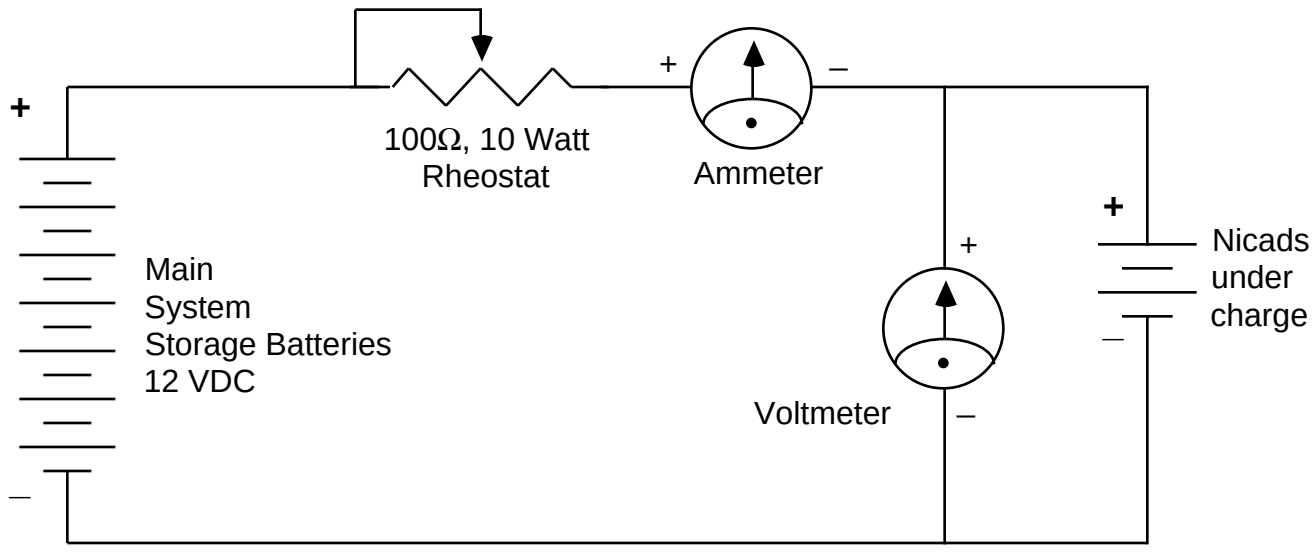
Nicads for you and me

The advantages of the nicad are obvious. We can refill them many times. In terms of savings, most nicads will pay for themselves after having been cycled less than 10 times. This means that the money you spent on the nicads would have been spent anyway on disposable batteries. So do your bit for your bank account and our environment. Stop supporting throw away technologies. If we can power our homes on the sun, then we can do the same with our portable tools and toys.

Next time on nicads

Next month this column will feature a 12 VDC electronic nicad recharger. This machine, called the "nicad pulsar", regulates both voltage and current. The nicad pulsar allows both unattended recharging and complete filling of the battery. It is solid state and very efficient. It is also easy to build, and we're going to supply you with all the info you need to make your own high tech recharging machine. Till then keep those batteries full!

Fig. 3- Recharging small nicads using a 12 VDC battery and a rheostat



Fuel: *its transportation, handling & storage.*

Alan Trautman

If an engine driven generator is your source of electricity, you have to provide it with fuel. Gasoline is the most common source of energy for engine/generators. Diesel and propane or LPG (liquified petroleum gas) are other sources of energy.

No matter which source of energy your generator uses, you are involved in some way with its handling. With proper care this task can be accomplished easily. If care isn't taken, problems with the carburetor (on gas engines) or fuel injectors (on diesel engines) will occur. These problems usually arise when contaminated fuel enters the fuel system.

Gasoline

If you are using a gas can to refuel your generator I have a few lessons I have learned over the years that will help prevent a few headaches. First, I do not recommend hauling gasoline in the trunk of a car, in the back of a station wagon or hatchback, or in the back of a pickup. Why, you ask?

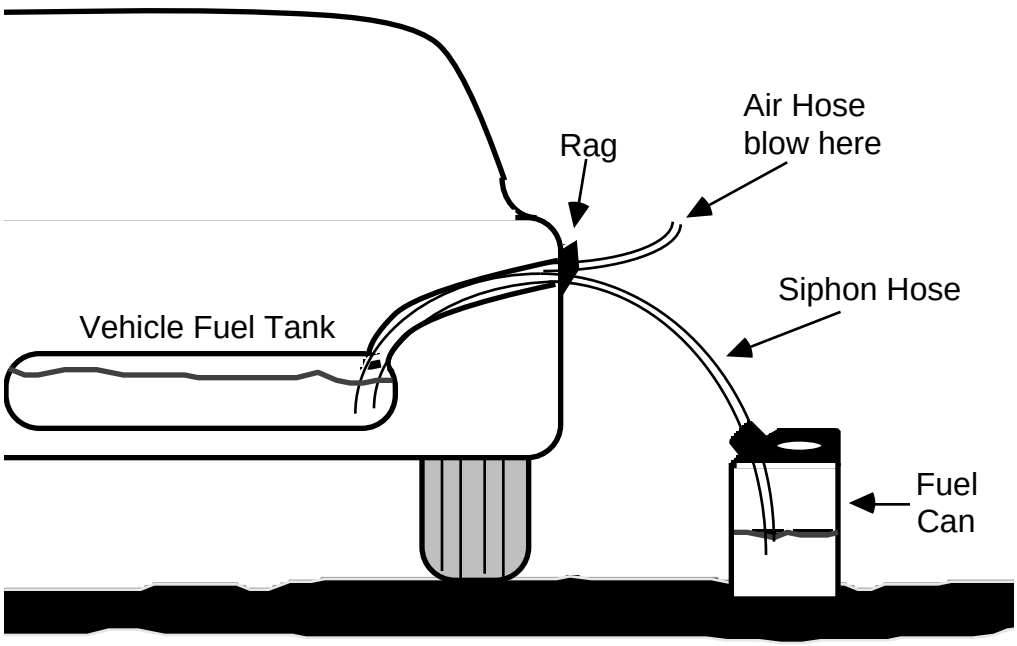
Hauling gasoline is very dangerous! In warm weather, gasoline expands as it warms up. If you have a can in the trunk or behind the rear seat, the fumes vented from the expanding gasoline are very unhealthy to breathe and may cause an explosion if ignited. Also, any spills will smell for days, even weeks. If you are hauling gasoline you are exposing yourself to another serious hazard, Fire! If you are involved in an accident, there is a chance the gas can could rupture and cause a serious or even fatal explosion and fire. Even if the gasoline isn't ignited it can burn on exposure to skin. If a car rolls over and leaks gasoline from a can onto the occupants, they will suffer skin burns just from being exposed to raw gasoline.

Well, haven't I painted a pretty scary picture so far? I want people to realize how scary gasoline can be, if it is not handled properly. How can I safely haul fuel, you ask? In the gas tank of your car or truck. Just remember to fill your tank before going home and siphon out what you need.

Siphoning gasoline, if you have ever done it, probably brings to memory the mouthful of gas you got and the seemingly days before before you quit tasting it. I have a fool proof way of siphoning gasoline with no chance of getting it anywhere but in the can where it belongs. Refer to the drawing below.

The first step is to put the siphon hose through the filler opening into the fuel tank and the other end of the hose in the gas can. Take a second hose about 2 feet long and insert it about 6 inches into the filler opening. Take a rag or plastic bag, wrap it around the two hoses and push it tightly around the filler. Take a breath of fresh air and blow into the air hose. This will create pressure in the tank, forcing gas through the siphon hose and start the siphon into the gas can. When the gas can is nearly full, pull the hose out of the vehicle and let the remaining gas in the hose drain into the gas can. Simple, huh?

Remember to take a breath of fresh air, never suck air through the air hose and NEVER leave the siphon going while you do something else. A person I know siphoned his pickup tank empty when he went to do some chore and forgot he was siphoning gas. An hour later he remembered but not before 5 gallons went in the can and 20 on the ground. A costly mistake!

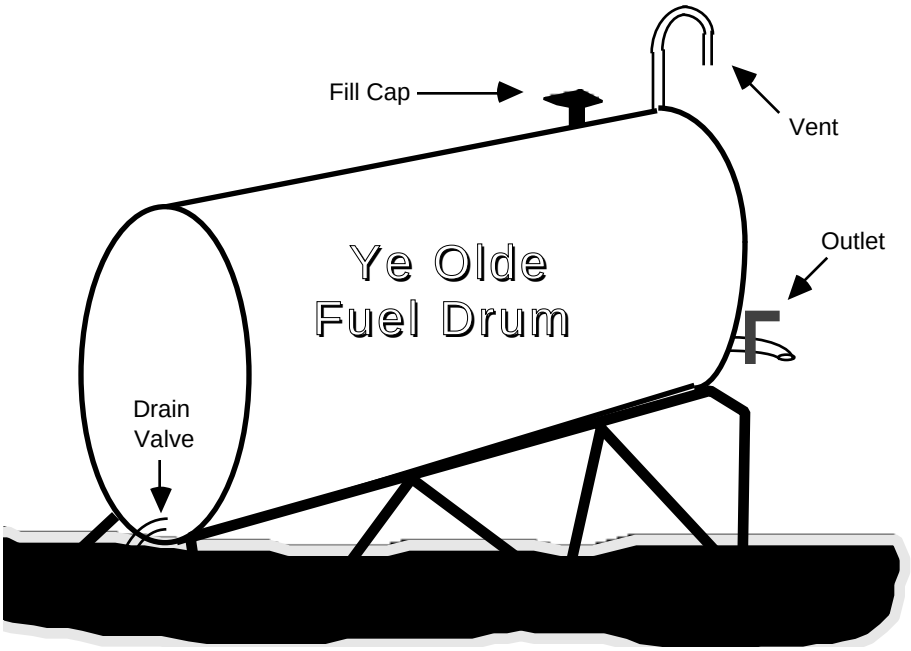


Let's talk about gas cans for home gas storage, not for hauling. I like the plastic types because they don't rust or dent and you can see how much gas is inside, from the outside. They even let light inside, so you can see any sediment or water build up. I have a plastic can I have been using for over ten years and it's still is in good shape. As with most plastics it is a good practice to keep them out of the sun. Sunlight causes plastic to break down and eventually crack prematurely. Keep any gas can, metal or plastic, out of the sun and

weather.

A gas can, left out in the rain, will eventually get water in it. This happens when gas gets warm during the day and cools at night. The cooling causes contraction that will suck water past vents and filler caps into the container. Keep your gas cans in a well ventilated, cool and dry storage area away from sparks and flame (gas hot water heaters included).

I haven't mentioned metal or "Jeep" cans so far but they are suitable containers none the less. The "Jeep" cans can be mounted in racks especially made for them and locked to prevent theft. The "Jeep" can is rugged but some what awkward to use. The large filler hose passes fuel quickly but sometimes causes spilling from overfilling. "Jeep" cans are the only container I would ever recommend for hauling gasoline. They were designed to carry extra gasoline for extended excursions beyond the range of the Jeep's fuel tank and are built extra heavy for rough use.



One more tip I have for those who use gas cans, is to never dump the last drop out of the can. Leave a small amount in the container. This way you won't inadvertently dump sediments or water into the tank of your generator. Empty the small remainder of the gasoline into a jar and examine it. Pour back the gasoline and DISCARD any water or sediment.

If gas cans and siphoning gasoline doesn't appeal to you then a storage tank may be the answer. If you live in an area accessible to a fuel truck, a large storage tank may be a feasible alternative. Usually you don't have to pay the road tax on each gallon of fuel and nowadays this can amount to 20 cents or more per gallon. 100 gallons, 20 dollars savings, something to think about.

If a fuel distributor in your area can service your needs, then you need to buy a tank and stand to put it on. In Oregon, most Grange Co-ops can set you up with a tank and stand. Contact your local fuel distributor for specific info on your location. They may either have or know where you can purchase them.

When setting up the storage tank, make sure the outlet is higher than the opposite end of the tank. Refer to the drawing. The reason for tilting the tank is to prevent any accumulation of water or sediment from entering the outlet tube. The drain valve, located at the lowest part of the tank, provides a convenient place to drain out any water or sediments. A clear jar is used so you can examine the fuel.
Water does not mix with gasoline so it will stratify on the bottom of the jar leaving a distinct line. Pour the gasoline back into the tank and dump the water out. Water gets into the tank from expansion and contraction. The tank and fuel expand during the day and contract at night. Air goes in and out of the tank through the vent. If the air has high humidity, some of this humidity will condense on the tank and will eventually collect at the bottom. The water droplets that condense on the metal tank will, after time, cause rust and rust flakes. These rust flakes make up most of the sediment found in a large storage tank.

DIESEL FUEL
If your generator has a diesel engine, I recommend that you follow the same procedures for handling diesel fuel as you would for gasoline, with one exception. I would install an after market water separator between the fuel tank and the primary fuel filter on the engine. A water separator can be obtained from a truck parts house or fuel injection repair shop.

Why, you ask, should I install a water separator when my diesel engine already has a primary and secondary filter system? The reason is serviceability. A water separator is like a very large sediment bowl. It has a large jar like bottom for easy viewing of the fuel inside. This allows you to examine the fuel at a glance for any water or sediment accumulation. A drain in the bottom of the bowl allows you to easily remove any build up of contaminants.

Another benefit of the water separator is an additional fuel filter inside the unit. With this additional filter and the separators increased ability to trap water and sediment, the fuel filters on the engine will last much longer between changes.

One other tip I have for those of you that have diesel generators, is to periodically add a fuel additive that will kill the bacteria that grows in diesel fuel. That's right, bacteria can live and grow in diesel fuel. This isn't a common occurrence but it can and does happen. It gets through fuel filters and can cause problems in the fuel injectors and fuel injection pumps.

PROPANE
Propane is an excellent choice of fuel for your home power plant. This fuel burns so completely that it hardly leaves any deposits in the combustion chamber and doesn't contaminate engine oil the way gasoline does. This feature of propane will help extend the life of an engine to about twice that of an engine run on gasoline.

The only real draw back of propane is the decreased BTU output. This means an engine will use slightly more fuel than

its gasoline counterpart and the engines output (horse power) is slightly decreased. This means more fillups if you are using 5 gallon bottles and slightly less power (watt) output of the generator. Balancing increased engine life against slightly decreased output, propane is the best choice for your home power plant.

Propane is best handled by professionals equipped for the job. Contact your local companies about bulk tanks and getting them filled.

In Conclusion
If you're burning fossil fuels, then take care. If fuels are not transported, handled and stored properly, they are potentially dangerous to us and damaging to the engines that use them.

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The Home Built BTU Boss

Don Hargrove

Do you heat your home or a portion of your home with a gas space heater? Well, here is a BTU saving device. It can be adapted to your existing or future space heater. My good friend Aron (Smokey) Baer, down in Sparks Nevada, has built several such devices. He has sent me the test results as follows.

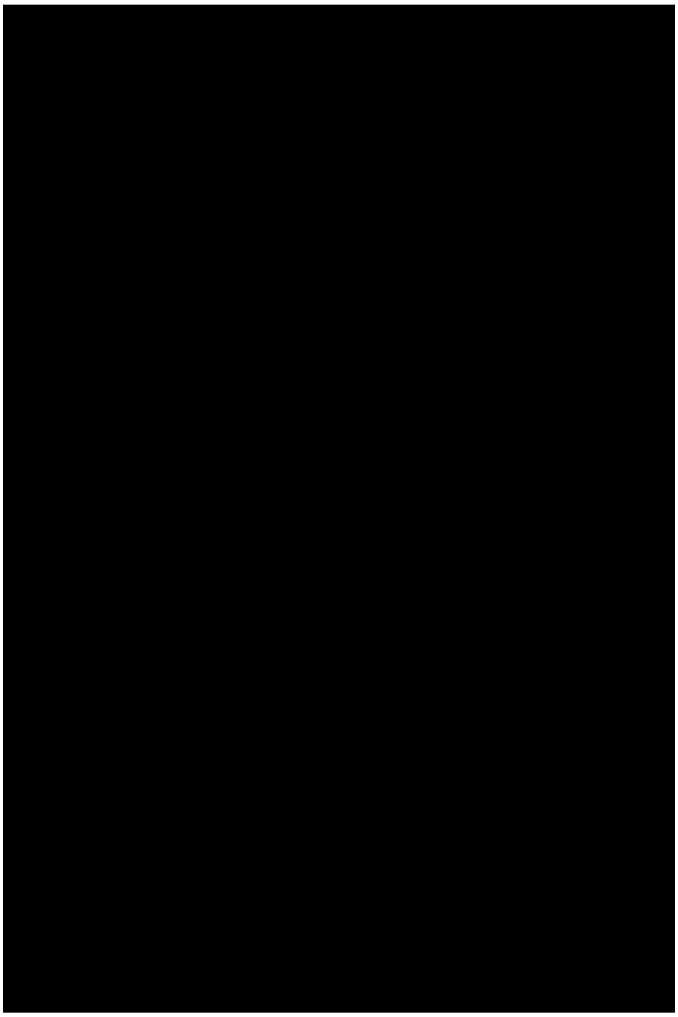
First he measured the temperature of the flu gases. At the point where the flu pipe enters the ceiling, the exhaust temperature read 400°F.! Being the tinker person he is, Smokey headed for the hardware store. With visions of heat & dollars saved he constructed the "BTU Boss".

Judging by the plans sent to me, it appears one can build this device fairly easily. Only simple hand tools, such as a light duty propane torch, drill, and screw driver are needed. I'll show Smokey's plans here, but you might want to change it to fit your own particular retrofit. In any event, you can get the general idea of how it works. Take the idea and improvise a design that fits your situation and materials.

When constructing the "BTU Boss" one will experience some difficulty fitting the "female" end of the tee's with the "female" end of the pipes. This is the point where the soldering is done.
The Test Results and Comparison

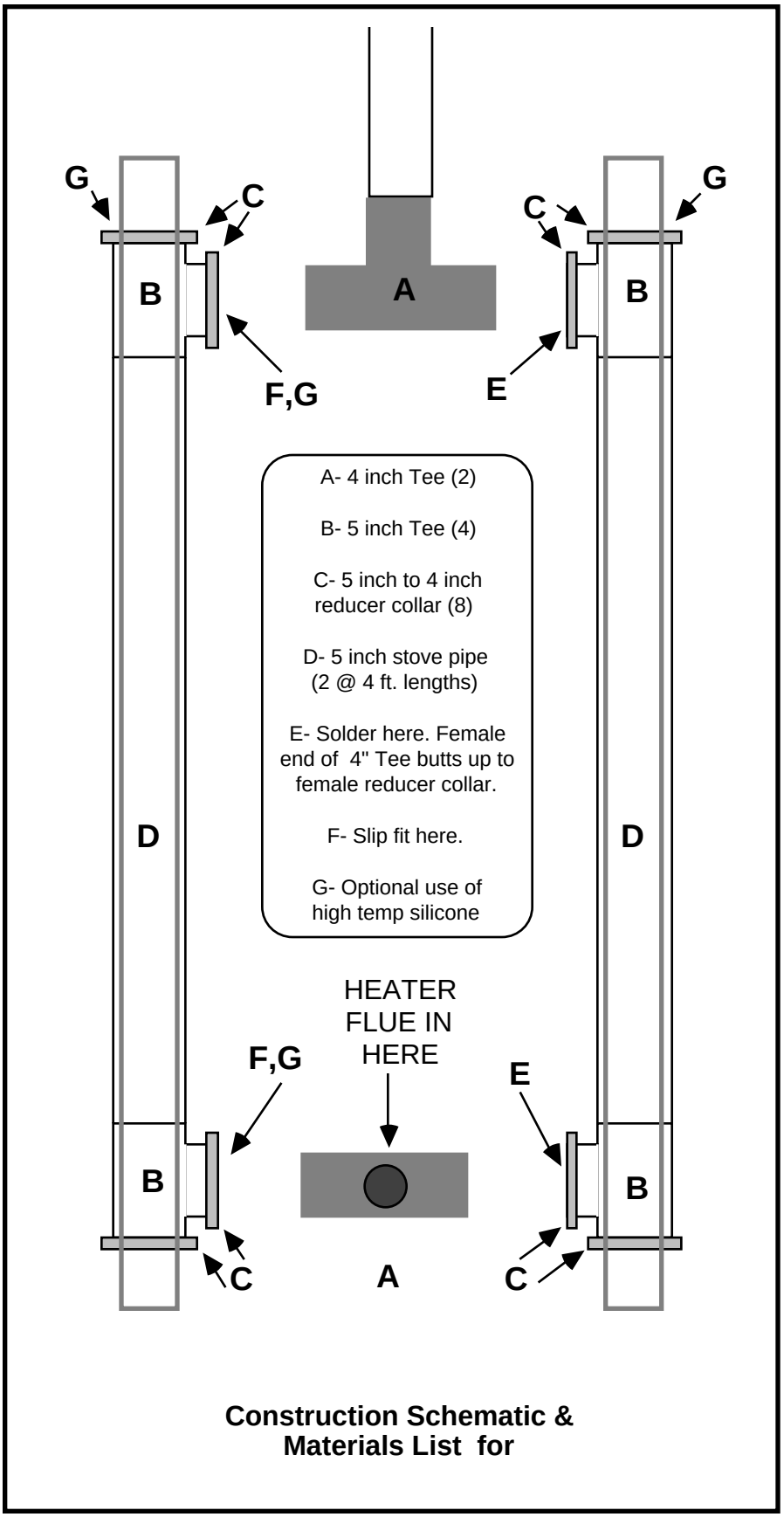
Having recorded the burn times of his heater prior to installation of the "BTU Boss", Smokey was now ready for the test. The first immediate and noticeable result was a dramatic drop in the flu gas temperature. The thermometer showed an actual drop from a previous 400°F. down to an incredible 150°F.! Smokey also knew that his previous burn time was 2.5 minutes and heater on every 8 minutes average. This means the total previous burn time was 18.75 minutes per hour.

Top of the BTU Boss



Smokey & the BTU Boss installed on a gas

After installation the heater averaged coming on every 15 minutes. The burn time was still 2.5 minutes each, but the total burn time was reduced to 10 minutes per hour or 8.75 minutes less per hour.
The reason the burn time stays at 2.5 minutes is because of the thermostats design. Some thermostats incorporate what is known as a "heat anticipator". This sensor anticipates its setting, in other words the anticipator shuts off the heater before all the heat reaches the thermostat. If it did not anticipate, there would be some overheating and under heating of the desired setting.

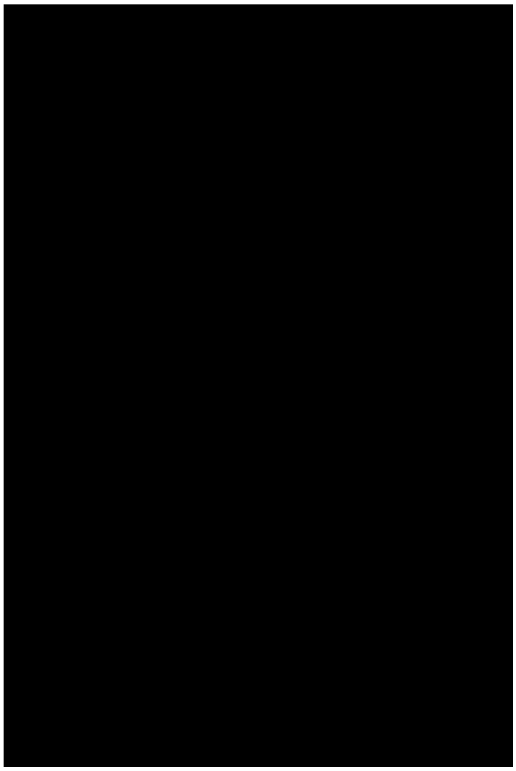


Construction Schematic & Materials List for

We can now evaluate Smokey's "BTU Boss" in dollars saved.
Heater Rating=80,000 BTU/hr
80,000 over 60 = 1333 BTU/Minute
1333 x 10 hr/day = 116,637 BTU/day
116,637 x 180 days (6 months) = 20,994,750 BTU/6 months
100,000 BTU in one Therm of Natural gas = 210 Therms
210 x .55/therm = $115.47 saved in one season (6 months)

The total cost for the "BTU Boss" was $80.00. So not only did it pay for itself the first winter but continues to give reduced monthly gas bills from now on.

The photos shown here are of a "BTU Boss" Smokey has installed in his neighbors mobile home. Mr. and Mrs. Burk no longer have to put up with noisy, uneven heating and less than 50% efficient forced air furnace. They now enjoy the quiet, passive qualities of the amazing, blazing, money saving "BTU Boss".



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☐	☐	Wind generator	☐	☐	Batteries
☐	☐	Water power generator	☐	☐	Inverter
☐	☐	Battery Charger	☐	☐	Control systems
☐	☐	Instrumentation	☐	☐	PV Tracker

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Things that Work!

tests conducted by the Home Power Crew

Here at Home Power central, the sun goes down and the lights go on, and on and on… We've been working late every night and this has given us the ideal opportunity to test the Solar Retrofit Consortium's 12 VDC fluorescent light. The fluorescent light was shipped to us by Kurt Ludlow of the Solar Retrofit Consortium, Inc. (SRC) in New York City. His company makes the 12 VDC inverter/ballast that produces the low voltage DC for the fluorescent tube.

Shipping Container & Documentation

The light arrived in good shape here in California, despite its cross country shipment. The container survived as did the fluorescent tube which was already installed in its fixture. The documentation on the fluorescent light is limited to exactly what you need to know to hook it up. No more and no less. Being a documentation freak myself, I'd like to know more about the performance and specifications of the unit. But the proof of the pudding…

Physical Examination

This fluorescent light fixture is a large unit measuring 49 inches long, 6 inches wide, and 6 inches deep. It is made of sheet steel and weighs about 12 pounds (shipping was less than $15 from NY to CA).

The fluorescent tube provided with the unit is the Sylvania, SuperSaver Plus, Warm White, 32 Watt Model (#F40SSP32/WW/RS). The light is shielded from direct view by a sheet metal valance.

Fixture Installation

The fluorescent light fixture is mounted via 3 screws to either a wall or the ceiling. We opted on ceiling mount in the center of the room. This fluorescent is a large light producer and we thought that ceiling mounting would distribute its light best.

We wired the unit to our 12 VDC battery pack, with a switch in line. The unit does not contain a switch, and this must be provided by the user. This is fine with us as we can locate the switch where we want, and not have it fixed on the fluorescent fixture itself. We wired the unit to the batteries with about 19 feet (total- both conductors) of 16 gauge copper wire.

SRC Fluorescent Operation

Well, you flip the switch and stand back. Get your fine work out because you got light! We are amazed by the amount of light that this unit delivers. Our workroom here at Home Power central is rather small, about 16 by 12 feet with an 8 foot ceiling. One SRC fluorescent light makes this room bright enough for fine work anywhere in the room. I saw dust bunnies lurking in corners, I saw cobwebs, I got out the vacuum!

In addition to high light output, the fluorescent tube used by SRC gives off a warmer light than any we've seen. This is a function of the WarmWhite tube they are using. This light is distinctly easier on our tired eyes than the cool white types offered in other 12 VDC fluorescent lights. The frequency of SRC's 12 VDC inverter/ballast is around 2,000 cycles per second. This light has none of the irritating flicker displayed by fluorescents operated at 60 cycles per second (on either grid or inverter 60Hz ac power).

We like the longer, 48 inch, fluorescent tube; it seems to distribute the light better throughout the room. The standard tube is also easier to find and cheaper to replace than the midget models used in many RV type fluorescent lights.

We eventually removed the valance & let the light shine unrestricted. In our application, we are working at desks and tables and the light is on the ceiling, so we didn't need the valance. Those of you wall mounting the unit will probably want to use the valance. It's easily removable with no tools.

At the time this is written, the SRC fluorescent light has been in nightly operation for over 3 months. We have experienced no failure during this time. We have used it on input voltages as low as 11.7 VDC and as high as 15.0 VDC. The inverter/ballast is heatsunk to the large sheet metal case. We can detect only moderate temperature rise in the unit regardless of the input voltage.

Power Consumption & Cost

Well all this light is swell, but how much power is it going to consume? Once again we were surprised. The SRC fluorescent light consumes 2.35 amperes of current at 12.45 VDC. We were expecting to see much higher power consumption than 29.26 watts (12.45 volts times 2.35 amperes equals 29.26 watts). The tube is rated at 32 Watts and we measure the entire unit's consumption at less than 30 Watts. This light is very efficient. The 2.35 ampere current drain is about the same as an incandescent car tail light lamp, but the SRC fluorescent gives off about 5 times as much light.

One factor affecting the performance of any DC powered fluorescent tube is the frequency of the inverter/ballast's operation. We've been experimenting with standard fluorescent tubes fired on high frequency ac and have found that the tubes become more excited at higher frequencies. This makes them deliver light more efficiently than the same tube fired at lower frequencies.

Before we talk price consider this. The largest cost of running an appliance in a home power system is not the price of the appliance itself, but the cost of the energy it takes to power it. In no case is this more true than lighting.

In our particular situation, having this light on our ceiling has reduced our nightly lighting load to about 1/3 of what we were consuming. We replaced three 30 Watt incandescent car tail light bulbs with the SRC light. In addition to this power consumption reduction of about 250 Watt-hours per day, we have about twice the light. At this rate, considering that our AE system makes and stores power at about $1 per kW.-hr., we are saving 25¢ per day, or $7.50 per month. The SRC light costs $65 and will totally pay for itself by saving power, in our system, in less than 9 months. After payback, it's all gravy!

On the down side…

Well, it's hard to complain about the SRC fluorescent light. One very minor problem is radio frequency interference (RFI). Home Power central is jammed with radio gear. Both Karen and I are hams and the com rack contains HF and VHF ham transceivers, scanner, CB, shortwave receiver, and a regular

ole TV. All this radio gear is directly wired to the same battery pack as the fluorescent light. If there's any RFI in the neighborhood, our system hears it. We experienced minor hash on the CB to the tune of about 2 "S" units. Channel 2 on the TV also experiences minor dancing glitches on the video when the light is operating. We haven't had time to add a deglitch capacitor across the fluorescent light's power leads.

Conclusion
SRC makes a very bright and cost effective 12 VDC fluorescent light. We like its large size, low power consumption, and standard warm white tube. At a retail price of around $65, it's a very good value. Contact Solar Retrofit Consortium, Inc., Box 34, 200 East 71st Street, New York, NY 10021-9998 or telephone: 212-517-3580.

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- 12 VDC Fluorescent Lighting
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Things that Work!

tests conducted by the Home Power Crew

For intermittent and short duration 12 VDC lighting it's hard to beat incandescent automotive lightbulbs. These bulbs shine in locations that don't see enough use to require the more expensive 12 VDC fluorescent lights. The biggest problem with car bulbs is the sockets and fixtures. Well, meet Tom Caton. He makes a nifty adaptor that lets you use car tail lightbulbs in regular 120 vac lightbulb fixtures. And he makes these adaptors using his own homemade electricity!

So why use an adaptor?
In the past those of us using car lightbulbs, like tail lights and dome lights, had very little choice of fixtures and sockets. We could scrounge a socket out of the junkyard and make our own lighting fixture; it didn't look pretty but it worked and was cheap. Or we could purchase 12 VDC lighting fixtures designed for RV use, but these are generally expensive and very poorly made.

Many of us have desk lamps, table lamps and floor lamps that are designed for the standard 120 vac, screw-in, incandescent lightbulb. These fixtures are well made, and can be easily modified to work on 12 VDC. The only wrinkle was the bulb's socket. We wanted to put a car lightbulb in a socket designed for the larger screw-in base.

So this is why we need this adaptor. It allows us to use 12 VDC lightbulbs in fixtures designed for the larger screw-in lightbulb base.

The Adaptor
The adaptor is made from a standard 120 vac male lightbulb base with a bayonet style car bulb socket soldered within it. The 120 vac base screws into the regular lighting fixture and the 12 VDC bulb fits into the bayonet car socket. Very neat and simple; there is no soldering for the user. It takes more time to tell about it than it takes to install.

The adaptor is well made with heavy materials and very good soldering. A truly solid state device, I'm sure that it will last much longer than I will.

Conclusion
It's time to get Aunt Edith's old floor lamp out of the attic and put it back to work on 12 VDC. This adaptor opens the whole world of ac incandescent lighting fixtures to the 12 VDC user. Cost of the adaptor is $5. This is inexpensive enough for a mass produced item, but consider that Tom makes every one by HAND. He uses only alternative energy for fabrication and soldering. Contact Tom Caton, Northern Lites, POB 874, Tonasket, WA 98855. Support home powered cottage industries!

Radiotelephone

Richard Perez

When you move out beyond the power lines, you leave the telephone lines behind also. Next to making electricity, communications is one of the biggest problems facing those of us living in the outback. One solution to this problem is commercial radiotelephone.

So why a phone anyway?
When most of us moved to the country the telephone was one modern convenience that we gladly did without. As time passed and we lost the tensions generated by rat race living, we found that we indeed still had a need for communications. In some cases, we have family & friends to keep in touch with, in others our livelihood depended on communication with boss, business, and/or customers. Radiotelephone is one solution to communication beyond the lines. Its major advantage is that it links us with the entire telephone network spanning all of this planet.

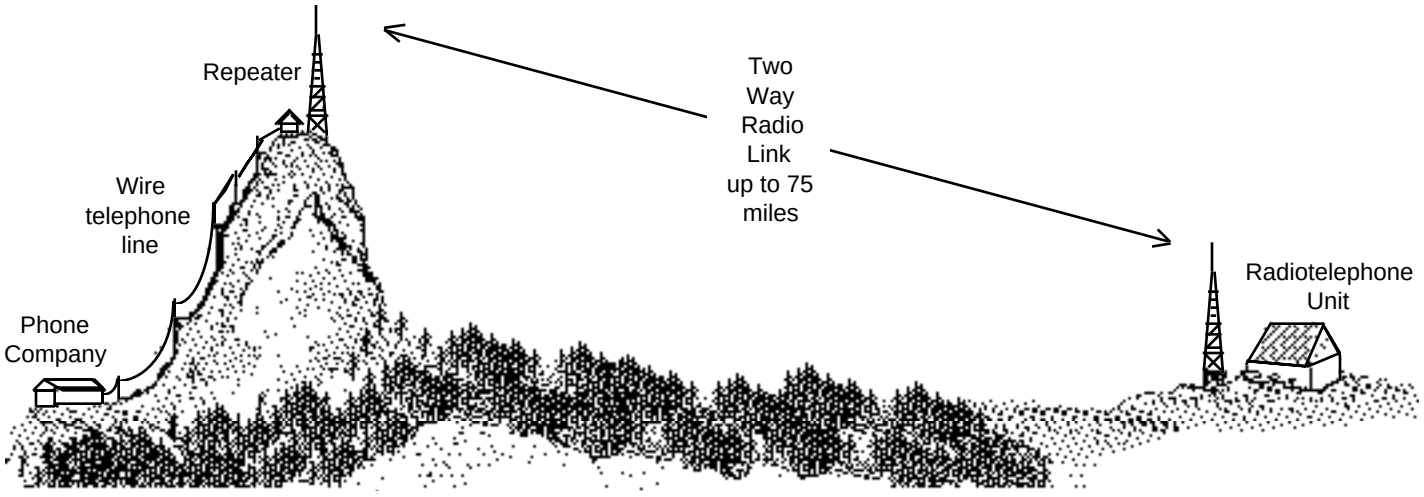
Types of Radiotelephones
There are two basic types of commercial radiotelephone services suitable for back country use. They vary widely as to type of service, range, cost, advantages and disadvantages. Let's go through each in turn and hopefully we can find something to ease your communications problems.

It is important to remember that all radiotelephone services are oriented toward mobile operation. Most of the users of these services are in motion in a vehicle. We country folks sneak into the system because we have the 12 VDC necessary to run the phone, and because the radiotelephone network doesn't care if our signal originates from a fixed antenna or a vehicle antenna in motion.

Radio Common Carrier (RCC)
This is the cheapest and least "telephone-like" of the mobile (portable or remote) telephone services.

Type of Service
RCC systems are independent communication services. When you use one of these systems you are dealing with an independent business that is licensed by the FCC to run a radiotelephone service. You are not dealing with the telephone companies directly. The quality and range that an RCC service delivers is directly tied to its equipment and drive of the RCC company. Some services spend the money necessary to install good equipment and see that it is maintained properly, while others don't. So investigate the performance of an RCC system with those already using it before you sign on.

The RCC service is simplex. Simplex operation is like a CB radio. You push the microphone button to talk and release the button to hear. Only one person in the conversation can talk at once, and when you're talking you CANNOT listen. Another name for Simplex operation is "push to talk". The opposite of Simplex is Duplex. Duplex means that the equipment (and thereby both parties) is capable of both talking and listening at the same time. Regular telephone communication is duplex; the person you are talking with may interrupt you and, even though you are talking at the time, you'll hear him.
In order to place a call into the regular telephone network, the RCC system requires that you go through an operator. All calls, either incoming or outgoing must be routed through an operator. There is no direct dialing out, or direct ringing in, with an RCC system. Think of an RCC system as a telephone switchboard where you can communicate with the operator via



a simplex radio link.

When you communicate through an RCC system you are not actually talking directly to the office where the phone lines are connected. In most cases you are talking with a repeater located on a mountain or high tower. The repeater electronically relays your radiotelephone's signal to the RCC office. So what really matters is where the repeater is located, not where the office is. Most RCC systems operate in the mid VHF range, with frequency outputs around 150 to 170 MHz.

Every RCC telephone serviced by a particular RCC company has exactly the same telephone number. You are distinguished by the RCC company by a Unit Number. While this is OK with family and friends, it is often cumbersome in business usage.

Range & Antennas
The RCC system is capable of spanning over 35 miles with radio signals. In any radio communication installation, the nature of the antenna is critical. Usage of a good fixed antenna, on a mast high in the air, can quadruple the range of an RCC radiotelephone designed to operate on a much smaller (and lower) mobile antenna. Terrain also plays a big role in the distance that an RCC unit can work. In flat lands, operation is fairly predictable. In the mountains, range will vary radically with location.

Cost
The cost of the RCC radiotelephone itself is moderate, between $600 and $1,200. The company running the RCC service will charge you between $25 and $50 per month for their service. In addition to this there is a charge for all long distance calls at the regular long distance rates. In some cases, RCC companies will charge for the amount of time you spend on the air. This varies widely from 20¢ to over $1 per minute of actual repeater usage and depends on the RCC company you are dealing with. Most RCC companies don't charge for air time.

Advantages
The prime advantage of an RCC system is low cost. The cost of the radiotelephone itself is the lowest of any type of radiotelephone service. In many cases the RCC company will sell, lease, or rent you the required equipment. The charges of the RCC company you are dealing with is substantially less than other types of radiotelephone services.

Disadvantages
First of all, the RCC system is simplex. While you may understand that only one party on the line may talk at once, the person you are talking to probably won't. Consider the perspective of the person you are talking to. He's got a telephone in this hand and doesn't understand that he can't use it like he always has. He has a lifetime of telephone experience telling him that he is talking on a duplex service. He may try to interrupt you while you are talking, but YOU WON'T HEAR HIM because you have the transmit button down and are talking at the time.

In our experience, it is virtually impossible to get the person you are talking with to realize this simplex situation. The net result is that communication is difficult. While this limitation may be OK with family and friends, it's death in business. RCC systems make communication complicated by using simplex mode on a telephone system that is in duplex operation.

Another disadvantage of RCC systems is that they are essentially party lines. All the customers of any particular RCC service company (and there will be many, otherwise the company wouldn't be in business) use the same frequency and equipment. This means that anyone in the system is free to listen to your phone calls, just as you can listen in on everyone else's calls. The RCC system is not for the shy or self-conscious communicator. So don't say anything on an RCC system that you don't want the entire neighborhood to know. A byproduct of everyone using the same channel for communication is that the channel gets crowded. Some RCC companies limit air time to 5 to 10 minutes per call.

Improved Mobile Telephone Service (IMTS)
The IMTS system is the regular telephone companies' effort to improve on the RCC system. In this case, you are dealing directly with Ma Bell or your local telephone company. In some areas IMTS is VHF, while in others it operates in the higher frequency UHF band. In general, the VHF units work better in the mountains.

Don't confuse IMTS service with the newer "cellular" type of mobile telephone service. The cellular type is only working in urban areas, and the cells are usually less than 10 miles in diameter. Cellular mobile phone is for short range urban mobile use. It is not suitable for back woods communication.

The application of repeaters is much the same as with the RCC service. You don't talk with the phone network direct, but through a radio repeater located in a wide coverage radio location. However, in this case the repeaters are being purchased and maintained by the telephone network rather than a small business. This means that the repeaters are of much higher quality, with better audio quality and longer range.

Type of Service
The IMTS system is full duplex. The transmitter and the receiver in the unit are both operating at the same time, and through the same antenna! This is a radio tech marvel. IMTS operation is indistinguishable from regular, land line, telephone operation. I ran an IMTS radiotelephone as a business line for Electron Connection for over two years. None of the people I talked to knew that they were using a radio link unless I told them. The system is so good and transparent that it is virtually identical to having a regular, hard wired, land line in operation.

Each IMTS radiotelephone has its own individual telephone number, just like downtown. This number must be programmed by an FCC licensed technician into the radio (cost about $25). The IMTS service uses direct dialing output and reception. There are no operators to deal with in this service. Making a call on an IMTS system only requires that you lift the telephone handset and dial the number, operation is identical to a regular telephone. Your IMTS unit can be reached by any telephone anywhere without the assistance of an operator.

The IMTS system is very highly developed. For example, in California there are 73 VHF IMTS repeaters working. In many areas of the United States, folks living in the country may have a choice of which repeater they wish to access. In the IMTS system I used, I was able to access three repeaters, one in California and two in Oregon.

The IMTS radiotelephones are designed to run from a 12 VDC battery system. The basic IMTS transmitter is limited in power

output to 30 Watts by the FCC. This means that the transmitter, which is about 50% efficient, consumes about 5 amperes of DC current from a 12 VDC battery. The transmitter is only activated when you are actually talking on the phone. My IMTS receiver consumes about 10 Watts, 0.8 amperes of 12 VDC. In order to receive incoming calls the receiver must be on. In a 24 hour period the radiotelephone's receiver will consume 240 Watt-hours, 20 ampere-hours of 12 VDC. Transmitter power is regulated by the FCC and most every IMTS unit will consume the same amount of power on transmit. Receiver design, however, varies greatly. So check the receiver's consumption before you buy it. If you leave the telephone active 24 hours a day, then even small differences in receiver consumption will add up.

Range & Antennas

The range of an IMTS system is between 35 and 70 miles . The IMTS system is designed for communication with moving vehicles. The antenna situation on a vehicle is marginal, so the IMTS system has to be very sensitive. The vehicle antenna must be small and low enough to clear overhead objects. The antenna situation for home use is much better. Stationary use allows us to employ a gain antenna, mounted on a high mast, to greatly increase communication range.

The telephone company running an IMTS system is usually very conservative when quoting range predictions for their system. So when you talk to them about a system, remember that they are used to dealing with mobile situations. Fixed use, with a proper antenna setup, can almost always more than double their predicted system range.

The IMTS system operates in the mid VHF range, from 155 to 165 MHz. The gain antennas suitable for this service are of two types: omni directional (works in all directions), and directional (works in one direction only). We have used the omni directional "Isopole™" made by Advanced Electronic Applications, Inc., POB C2160, Lynnwood, WA 98036, call: 206-775-7373. This antenna costs about $60. and is available at just about any VHF radio store. Range with this antenna, mounted on a 36 foot, or higher, mast, is well over 50 miles depending on terrain.

The directional antennas for IMTS service are called "Beams" because they focus the radio energy output of the antenna in one direction. This focused beam output is pointed at the repeater that you desire to access. Operation is much like a TV antenna which must be pointed at the station to be received. Once the antenna is positioned facing the IMTS desired repeater, further rotation of the antenna in not necessary and it may be secured in that position. The use of a beam type directional antenna can more than double the range over an omnidirectional antenna, and quadruple the range over a mobile antenna. If you are living more than 50 miles from the IMTS repeater, or if you live in a difficult radio spot like the bottom of a canyon, then use the beam. Beams, like every other antenna, work best when they are high in the air. Consider 36 feet the minimum mast height.

Hand in hand with a gain antenna comes a good grade of coaxial cable. This coax cable must get the signals to and from the antenna efficiently. Use RG-8U (for feedline lengths over 50 feet) or RG-8X (for runs less than 50 feet). This cable will cost about 35¢ per foot. The higher operating frequencies of the IMTS system make good coaxial cable essential.

Cost

Those of you interested in an IMTS system, please sit down if you are not already doing so. Fasten your seat belt and hold on to your wallet. The phone companies consider the IMTS a business service for on the go, affluent, executives and price it accordingly. The cost is high and this is the biggest drawback to IMTS.

The actual radiotelephone unit will cost between $1,000 and $3,500. depending on the type and manufacturer. Since these radios are designed for mobile service, they are very ruggedly built. The imported models costing around a grand seem to work well, but they lack the heavy hardware and longevity of the mid priced domestic units. Check on service and installation help from the company before you buy from them. During the two years I operated the Motorola Pulsar IMTS unit it gave me not a lick of trouble.

Antenna, mast and coaxial cable will cost about $150 to $300. Considering the cost of the basic IMTS transceiver, scrimping on the antenna system is a very false economy. Why pay thousands of dollars for high tech electronics and then have it work poorly (or not at all) because you saved a hundred bucks on the antenna system.

If you think that the above is expensive, hold on because we getting to the phone company's piece of the pie. There is usually a $200 to $300 deposit required to start the IMTS service. The basic rate for service is low about $25 to $60 per month. The phone company does, however, charge for air time and long distance. In my experience, it is this air time charge that is the most expensive single component in the entire system. The cost figures here are what I was being charged in northern California from 1985 to 1987. Yours may be lower or higher, so check with your local phone company.

In my situation, air time was charged by the minute or fraction thereof. There is a sliding rate based on the duration of the call and the time of day (locally at the IMTS repeater) that the call is made. For example, for the hours of 8AM to 8PM on weekdays, the first minute on the machine cost 50¢, minutes 2 through 5 cost 70¢ each, and minutes 6 and over cost $1.05 per minute. During 8PM to 8AM (overnight) and on weekends the rates were 40¢ for the first minute, 45¢ for 2 thru 5, and 55¢ for minute 6 or more.

The IMTS pricing structure makes it evident that they want you to keep your calls short. Air time is charged for BOTH incoming and outgoing calls. This is difficult to explain to a person calling you. He's called you and his entire telephone experience tells him that he is picking up the bill. However, you will receive a bill for the air time on the incoming call. During business hours, the air time on the call is much greater than the next expense-- the long distance charges. If the telephone you place an outgoing call to is not within the local telephone area where the REPEATER is located, then regular long distance rates apply and are added to the air time of the call.

Let's total all the costs up. There is about $2,000. in hardware-- the IMTS radiotelephone, antenna, mast, and cable. Air time will cost an unknown amount depending on how much you use. In our case we were running a business over the IMTS system. Most of our calls were during business hours. Almost all of them were also long distance. Our air time combined with long distance was running us about $10

per call and over $300 monthly. In a years time we had pumped over $3,000 into the phone system. This is a lot of money for communication. But having a telephone, especially one that was full duplex, greatly boosted our business which more than paid for the system. So I think the lesson to be learned here is that IMTS is suitable for business use. Personal use of the system is cost effective only if you keep the calls short in duration and make them after 8PM or on weekends. When you use IMTS during business hours, think a dollar a minute & you'll about right.

Advantages
The prime advantage of an IMTS radiotelephone is that it works just like a regular telephone. It is full duplex and has its own individual telephone number. The IMTS service has, in most cases, longer range and better audio quality than RCC.

Disadvantages
The major disadvantage to IMTS service is cost. It's expensive. Unless you have a business to pay the bills, it's not really affordable for the average country homestead.

In Conclusion
Radiotelephone services offer communications to remote sites. The RCC service is really not very expensive, while the IMTS system certainly is. For those who can afford and need radio access to the regular telephone system, a radiotelephone is the answer.
For those who communications needs are less rigorous, there is still CB and Amateur radio. Both these radio services are adequate for emergency use. It is legal to use CBs for business purposes, while it is not for Ham radios. A good alternative to radiotelephone is to communicate via CB with a neighbor who has a regular land-line telephone. Next month we are going to talk about Ham radio. Topics for the future communications columns include more antenna projects, cordless telephones, TVs, satellite TV, and FM stereos.

Just because we live in the middle of nowhere doesn't mean we can't listen and have our say. We just have to do it the hard way. So, what else is new?

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Basics of Electricity, Part 2

R.L. Measures

In the previous article I discussed the basics of electricity and the related terminology and abbreviations for using Ohm's Law. This law is essential for working with electricity. The best way to become fluent with Ohm's Law is to solve some electrical problems using it.

Review -- Basic Ohm's Law describes the relationship between the rate of current flow [I or i] in amperes , the electrical pressure [E or e] in volts and power [P or p] in watts: P=IE for direct current and p=ie for alternating current. This means that power or work is equal to amperes multiplied by volts. By playing algebraic musical-chairs with this formula we can also say that I=P/E and E=P/I. So if any 2 of the 3 quantities are known, the unknown, 3rd quantity can be found.

Here are some sample problems:

1. An aircraft landing light is rated at 13.8Vdc and 100W. How many amperes are needed to operate this light ? Solution: Using I=P/E, I=100W/13.8V, I=7.246A. If the ampere and voltage ratings were given and we wanted to know what the wattage or power rating is, we would use P=IE; P=7.246A x 13.8V = 100W. If only the ampere and wattage requirements were given, we could find the voltage rating by using E=P/I; E=100W/7.246A = 13.8V.

2. An alternating current electric heater is rated at 120v, 1500w. How much current will the heater require ? Using i=p/e, i=1500w/120v; i=12.5a.

3. A flashlight lamp is rated at 2.4V at .83A. How much power in watts does this lamp consume ? Using P=IE, P=.83A x 2.4V =1.992W

The unit of resistance to the flow of electrical current is the ohm [Ω]. One ohm is defined as one volt/ampere or volt per ampere. For example, if a circuit requires one volt of electrical pressure to cause one ampere of current to flow, the resistance of the circuit is one ohm, which would be written as 1Ω. If 3 volts of electrical pressure is required to cause one ampere of current to flow, the resistance is 3 volts per ampere or 3V/A and the resistance is 3Ωs. Ohms and volts per ampere [V/A] mean the same thing. If 100 volts were required to cause 1 ampere of current to flow, the resistance would be: R=E/I =100V/1A= 100Ω.

The resistance can also be calculated by using other than one ampere of current since the ratio of volts to amperes is constant even if the voltage is varied. If 10 volts causes a current of .1 ampere to flow in a circuit, the resistance, R, is equal to 10V/.1A = 100Ωs. The power dissipated by the resistor is P=IE; P=.1A x 10V=1 Watt. If 1200 volts were applied to this circuit, a current of 12 amperes would flow because the ratio of volts/amperes with a 100Ω resistor is always 100/1. The power dissipated by the resistor is P=IE; P= 12A x 1200V=14400 Watts.

The three basic formulas that involve resistance are R=E/I, I=E/R and E=IR. These formulas are also referred to as "Ohm's Law" although they are really spinoffs of basic Ohm's Law.

Here are some typical Ohm's Law problems:

1. A length of wire is known to have a resistance of .2Ω. If the wire is carrying 11A of current, ¨ how much Electro-Motive-Force or voltage [E] will be lost in the wire ? and ¡ how much power is lost as heat in the wire ? Solution: E=IR; E=11A x .2Ω=2.2V. . The power that is lost in the wire can be found using P=IE; P= 11A x 2.2V= 24.2 Watts [W]. This would be about half of the available power from a typical solar-panel.

2. A starter-motor for a tractor's engine is rated at 10V at 230A. How much resistance does this motor have ? Using R=E/I: R=10V/230A=.04348Ω. Another way to say that the resistance is .04348Ω is to express it in thousandths of an ohm, or milli-ohms. This is done by multiplying the number by 1000 and, so that we don't change the value, dividing the units by 1000. The abbreviation for milli is m, so the abbreviation for milli-ohms is mΩ. So we could also say that the resistance is 43.48 milli- ohms, which would be written as 43.48mΩ.

Note: it is a common practice to express electrical quantaties as a number between 1 and 1000 along with the appropriate suffix that makes this possible. The units for thousands is Kilo, which is abbreviated as K. Example: a DC current of 130,000 amperes would be 130 Kilo-amperes or 130KA.

3. How much current [I] in amperes will flow through a resistance of 17Ω when 4V is applied ? Solution: using I=E/R; I=4V/17Ω=.2353A. This could also be expressed in milli units. So we could also say that the current was 235.3mA.

4. A water pump is rated at 12V, 9A. The water pump is to be operated 164 meters away from the storage battery that will be used to operate the pump. The 2-conductor #10 gauge copper wire that connects the pump to the battery is 164 meters long. This wire has 1Ω of resistance to the flow of current. How much voltage must the storage battery provide if 12V at 9A are to delivered to the pump ? Solution: The voltage that is lost or dropped in the wire can be found by using E=IR; E=9A x 1Ω = 9V. So 9V more than the delivered 12V =21V must be provided by the battery. If only 12V were provided by the battery, there would not be enough voltage remaining after

making the trip through the resistance of the wire to operate the pump according to the manufacturers ratings. The performance of the pump will suffer. In some cases, this can result in motor stalling, overheating and premature motor failure.

Ohm's Law and its related formulas are a useful tool to anyone who is not connected to a public electric utility system. The "other side of the coin" is that electric utility companies seem to prefer that their customers understand as little about volts and amps as possible.

The Magic Sun

Robert L. Neuileb, Ph.D. and Marilyn K. Neulieb, M.S.

Barren and molten, the new planet earth first orbited the sun five to ten billion years ago. Even after the crust solidified and the depressions filled with water, this barrenness persisted. Chemical elements and simple compounds were randomly scattered on the surface. Organization of the elements into complex organic compounds was unknown.

The creation of life over two billion years ago and its subsequent events have produced myriads of complex organic compounds from these scattered elements. This creation converted barrenness into living oceans, majestic forests, lush prairies, diverse and productive estuaries and lowlands; it even vegetated the deserts. Hardly a place on earth has been immune from the effects of life. The earth's surface has been transformed from dust, rock and sterile water into life-sustaining soil and seas. The randomly scattered elements of the crust have been ordered into the complex chemistry of life, the delicate petals of flowers, the human brain and numerous living organisms.

Man, too, has created order as exemplified by large cities, complex transportation networks, and facilities for power generation and transmission. But man's work is usually accomplished by disorderly by-products. The barrenness of many strip mines, discussions of creating large areas of national sacrifice in the West to facilitate shale oil production, and the still-denuded mountainsides of parts of Europe which the Romans exploited for timber for ships are just a few of the expanding reminders that man's order has brought disorder. The obsolete, worn, and discarded products of man have not become the foundations of new, more complex products, but rather of junk yards, air pollution and landfills. It is said that trash is man's monument to order.

Waste is an abundant product of natural systems, too. Like the works of man, all living organisms produce waste during life and eventually become waste upon death. Some forests and grasslands produce eighty-five pounds of solid waste per acre each active year. Yet nature doesn't have trash heaps. This trash becomes an integral part of present and future order. New plants grow from fallen trees which soon become soil. Thus even more life will be supported.

Scientists are beginning to understand why man's attempts to create order seemingly create disorder and why attempts to correct this disorder may, in turn, create even greater disorder. The Second Law of Thermodynamics tells us precisely that net disorder will result from production and use of energy. In any system involving energy exchange, there is always created more disorder than order. The net result of production and use of energy must be the creation of disorder. Yet natural systems have seemingly repealed this law. What magic do the natural systems possess? Can man learn the secret?

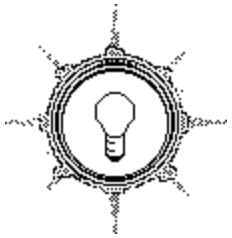
The magic is the sun. The natural systems have not repealed the Second Law of Thermodynamics. They simply utilize the only source of energy readily available on earth that is free of the necessity of causing disorder on earth. Oh, yes, the Second Law states more disorder than order is created through the generation and use of the energy in the natural systems. However, much of the disorder can be confined to the sun, the magic sun. Thus, net order can be created on earth. In contrast, in recent years man has concentrated primarily on earth-based energy sources. The creation of disorder, at least initially, has also occurred on the earth. This disorder, as it must, has exceeded the order created.

Disorder, such as that caused by strip mining, cannot be corrected by man alone. But with proper planning, man can encourage the sun. The natural process of restoration which is driven by the sun's energy can be shortened when the topsoil is preserved and the water is protected from contamination. In essence, man cannot create net order on earth. This role is reserved for the sun. Man can only assist.

The sun not only provided and continues to provide the energy for the establishment, development, maintenance and restoration of living processes; but it also provides energy to preserve the order of cycles vital to life. One such cycle is the water cycle which involves the separation of freshwater from saltwater. Many organisms, including man, depend on this separation, this creation of order. The winds driven by the sun's energy disperse this freshwater along with oxygen and carbon dioxide to living organisms around the globe.

With study, ingenuity and determination, the sun's energy may serve many of our needs. Technologies to capture the winds and radiant solar energy are emerging. However, there is no assurance that the use of solar energy will create order on the earth. For millions of years, fires on prairies and forests alike have been started by lightning from sun-driven storms. The magic sun has repeatedly converted prairies and forests into a disordered scattering of ashes. The sun can work its magic for man, but it comes with no guarantees, only opportunities.

Home Power's Business



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?

Letters to Home Power

Letters printed unedited. We'll print your name & address if you say it's OK.
Compiled by Karen and Glenda

Hello Folks!

We really enjoyed getting this copy of Home Power. A friend of ours gave it to us- he got it from Richard Perez's brother Michael in San Antonio-- Michael and Lisa have been friends of mine for over 7 years. Just recently we learned of Richard's occupation. We tried to get a copy of the Battery Book in San Antonio, but Bookstop (the biggest bookstore in the area) has been out for quite a while.

We live on 16 acres in Central Texas about 65 miles North of San Antonio. We have no electricity and a windmill pumps our water. We use oil lamps for light, propane heaters or wood for heat (also propane stove) and we have a "Calentadora", a Mexican wood burning hot water heater (which is extremely efficient, 30 gallons heated in just 15 minutes with a handful of building scraps!!!). We use a gas generator for any power we need, power tools, or occasionally a blender or other kitchen appliance, etc. We hope to set up a DC system in our house (which we are now in the process of building) and to use our windmill for power also. We need info on this!!! We live in a WINDY, SUNNY area and we can really envision generating ALL our own power. I, myself, am expecting our 3rd child and would Love a washer and a Real refrigerator. Our propane fridge is grossly inefficient, using almost $20.00 of propane per month in the summer and it doesn't get cold enough to make ice. Those are my only complaints, no fridge or washer, but we've been doing it this way for a few years so I know we can do it a while longer.

Your magazine is REALLY NEEDED. There's a radio talk show we listen to here called KLBJ. Cathy Cronkite (yes, Walter's daughter) is the host and there's alot of talk on energy conservation. I've called in the address of your magazine so maybe you'll get some subscriptions, but I'd also like to call & give them your address as a possible guest (via long distance, of course) what you're saying is important for us here in Central Texas, South Texas Nuclear Project wants to start up this year, amidst serious protests, if people could understand the alternatives. Anyway keep up the good work, we look forward to new info. Could you send us your advertising rates?

Thanks so much-- Good Luck!!

Diane Rolfe, Fredericksburg, TX

Editor: Thank You, Diane! That one phone call brought in 45 subscription requests! That's the kind of thing we need to help spread the word.

Dear Mr. Perez,

What a super magazine! How incredibly fortunate that I somehow ended up on your mailing list, and I've enclosed a subscription form to cinch the deal. Although I'm not now a home power producer, I do have occasional need for batteries and PV panels to power oceanographic and meteorological data acquisition equipment, and being an oceanographer by training and not an electrical engineer, I've found many of the articles in HOME POWER right on target. My enthusiasm for your magazine, however, stems from my work with a renewable energy resource that is not as well known as wind or solar, but which has great promise, and that is the power of ocean waves. More on that in a moment, but first some quick business.

Having recently started my own company, I know some of what you're going through (will weekends and vacations ever exist again?). Anyway, enclosed is a check for $52.00 - $2.00 for a back issue of HOME POWER 1 and $50.00 to help - you gotta sleep!!

So a little bit about wave energy. Its first practical use for generating electricity was actually by a home power producer! In 1910, one M. Bochaux-Praceique supplied his house on the coast of France with 1 kWe from a turbine driven by air pumped by the wave-induced motion of a water column in a vertical bore hole located in a seaside cliff. Widespread commercial application of wave energy did not occur, however, until the mid-1960's, following Commander Yoshio Masuda's research in Japan on a wave-powered navigation buoy. Since then, over 1000 such generators, typically rated at 50-100 watts, have been sold by Ryokuseisha Corporation, and recently a competitor, marketed by Munster-Simms Engineering of North Ireland, has appeared on the scene.

In the mid-1970's, the industrial world's fascination with large central generating stations quickly carried the technology (on paper anyway) into much larger schemes, epitomized by the British government's development program for a 2 GWe wave power off the west coast of Scotland. Such attempts to put wave power on an equal footing with nuclear and coal-fired plants were unsuccessful. A market does exist, however, for smaller plants (500 kWe - 1 MWe) to provide energy for islands and remote coastal locations now served by diesel generators.

This export potential has led Norway, a country that is itself rich in conventional hydropower, to build two demonstration plants on the island of Toftestallen, located off its North Sea coast. The cost of the plants was shared by the national government and private industry, and they began operating in 1984-85. Kvaerner Brug's Multi-Resonant Oscillating Water Column, rated at 500 kWe, relies on the same basic principle as Bochaux-Praceique's home power plant. Major improvements have been made to the air turbine (a totally new design, the Wells turbine, originally developed under Britain's national wave program). Also rather than a simple bore hole, a concrete caisson, whose heaving water column motion resonates with the most commonly occurring wave frequencies, has been built into the island's cliff wall. Photographs in the enclosed brochure give some idea of the size of this plant.

The other demonstration plant, developed by Norwave A/S, uses a tapered channel to funnel waves into a basin in the island's interior. The waves increase in height as they travel into the ever-narrowing channel, spilling water over its sides. Continual wave action maintains a relatively constant head some 3 m above sea level. Water drains out of the basin through a 350 kWe Kaplan turbine.

The two Norwegian devices are fixed, but floating devices have also been tested throughout the world. Among these are a 1 kWe prototype Wave Energy Module on Lake Champlain in Vermont, a three-buoy 30 kWe power plant in the Baltic Sea off the coast of Sweden, and a 3-4 kWe device on the Caspian Sea in Russia. Active wave energy research also continues in Japan and Great Britain, as well as the United States, Canada, Ireland, Portugal, and China.

The wave energy resource is fairly concentrated compared to that of the sun or wind. Typical levels are 5-10 kW per meter of shoreline on the U.S. East Coast, 20-30 kW/m in California and the Pacific Northwest, and 15-20 kW/m in Hawaii and the Tradewind zones of the world. Outside of the tropics, wave power levels are much higher in the winter than summer. The wave energy resource in such latitudes almost perfectly complements that of the sun, hence the name of my

company. One dream I have is to be involved in the design, construction, and operation of a community power plant that utilizes wave devices and PV panels for its renewable energy supply, with a diesel (or better yet, biomass or waste-derived fuel) generator for calm, cloudy days. I'm hoping that your magazine will put me in touch with folks who might want to be part of such a project some day, be it those who can provide technical knowhow (any electrical or hydraulic engineers out there with a love of the sea?), those who might be potential end-users of the power, or those who just think its a neat idea.

It is even possible that utilization of wave energy may be economical for the home power producer. As the technology matures, it's something I'd like to explore. My feeling right now, however, is that for best economics and minimal environmental impact, the wave resource is probably better utilized at the community level rather than by individual homes.

Perhaps of more interest to the homeowner (particularly those who have gotten away from it all and find themselves on an island without an adequate fresh water supply), is wave powered desalination. One device that is near commercial production can be installed by two SCUBA divers working out of a small boat. The heart of this device is a submerged hydraulic cylinder, which is stroked by the heaving motion of a float or buoy and pumps seawater through a reverse osmosis membrane. A small prototype has been operating off the southwest coast of Puerto Rico and produces 250 gallons per day in waves 3 feet high. An article is enclosed that describes this in more detail.

If any of your readers are curious as to whether wave power can be put to work for them, they should feel free to contact me. Likewise, if anyone has developed their own wave energy device, I'd like to hear about it. Amazingly good ideas seem to come out of grass roots efforts, and one of the best things about your magazine is that it encourages the kind of interchange that brings such things to light.

Best of luck to you, and may Home Power be the success that you wish it to be. And if the gods are kind, let's hope it can be done in a 40-hour week, better sooner than later!

Sincerely Yours,
George Hagerman
SEASUN Power Systems
124 East Rosemont Ave.
Alexandria, VA 22301-2326
(703) 549-8067

Good morning. Hope you are having a good mail day!

Continuing on soldering from HP#3, pg. #44--Tried to find the conductivity of solder in my limited library, with no luck. However, the percentage conductivity of copper is 100%, aluminum is 53%, tin is 11.3%, and lead is 7.6%. And found a statement in "Principles of Electrical Engineering", Timbie and Bush, that says "the resistivity of alloys is nearly always higher than any one of the constituent metals and is always higher than that of the constituent metal of lowest resistively." Which makes solder an even poorer electrical conductor than I thought. Maybe less than 10% of copper. Can you put a number on this? Talk about connection and contact resistance is useful, even critical, and often neglected.

12 VOLT SOLDERING IRONS-- Weller makes a very good one, TCP12 field soldering iron (also available, the 24v, TCP24) 30 watt, temperature controlled. A little slug of magnetic alloy in the tip attracts a magnet closing a switch to the heating element. When the proper temperature is reached, the alloy becomes non-magnetic, and the switch opens. Tips are available in a variety of shapes, sizes, and temperatures (600°, 700°, and 800°F.). The biggest and hottest tip, PTB8, is the one I use most. I like a PTK7 (700°) for general electronics work. With the big tip it can just solder two #10 wires together. I don't have a current price list, but would guess wholesale at $30 or $40 w/one tip, and $4 or so per additional tip.

What's so nice about this iron is it cycles on and off, mostly off when not in use. Poke it on something, it snaps on and stays on. Saves a lot of power when idle, which it is most of the time while wiring something. This makes it well worth the price. Well made and dependable. Elegant.

A drawback is the 30 watt size. Fine for light wiring and electronics. Sure wish Weller made a 75 or 100 watt one like this. Since they don't, I use a small soldering copper that I heat with a torch for bigger stuff. Cheap, works well, but not so convenient or safe, and a whole lot slower. Anybody know of a high-powered 12 volt soldering iron?

12 VOLT POWER TOOLS--I've got a couple of 12 volt Milwaukee drills, a 1/4 inch, #0235, and a 1/2 inch, #1130-1. They also make a 3/8 inch, 30235. They look just like the standard Hole-Shooters except for a yellow cord and a funny plug, and they draw about 10 amps in light use and about 35 amps when you lug them down. Very good professional quality, as you would expect from Milwaukee. I use mine alot, hard. The sad part is they quit making them a few years ago. I'm told most of them were sold to utility companies for working around hot lines. Maybe folks can track down used ones. They are worth hunting for.

PLUGS AND RECEPTACLES-- Suitable connectors for 12 volt stuff. When is NEC (National Electrical Code) or NEMA (National Electrical MAnufacturers assoc.) going to come up with a standard for low voltage plug? Those cig. lighter junkers are pretty bad electrically and mechanically, but the only ones accepted as standard, as far as I know.

I mentioned the funny plug on the Milwaukee drills-It's an old straight blade type, tee configuration, (see small graphic KP) 250v., 20a., NEMA 20-2. It has good retention, low contact resistance, and most of us have never seen it before, so no confusion. They are still available for replacement use (Hubbell #5552-B receptacle, and other brands) but expensive because of limited manufacture. I've found them in the electrical piles in junk stores, enough for my own use. I think it would be a good one to standardize on, especially since Milwaukee used it for years. And if the RV market had to use them, the price would come down. How do we pressure NEC and NEMA? Who has other ideas of a proper plug/receptacle?

I'll be traveling in China for the next couple or three months, looking at technology. Does anyone have contact names, addresses, or locations of anything especially interesting? I will receive mail sent to me care of: Betty Richardson, Beijing Foreign Studies University, Box 8110, Ext. Box 70, Apt. 411, Beijing, China. To be helpful, suggestions would have to be mailed by mid-April or so at the latest. I'll try to do an article for HP on anything relevant I see (sail powered wheelbarrows? yulohs?) It would seem the Chinese, by the nature of their economy/intelligence/culture, are big on alternative energy/appropriate tech. Would it be asking too much for you to airmail a copy of HP#4 to the above address for show and tell? Will take #3 with me.

Keep at it. You ARE appreciated. But don't work yourselves to a nervous breakdown. Ain't worth it, except to us out here.

Fred Richardson, Richardson Marine Electric
Waldron, WA 98297

Dear Richard and all,

Greetings from rural Northwest Arkansas. I am writing to give you a brief rundown on my alternative energy system, and to offer a few nuggets of hard won advice.

I live in a hand built passive solar house roughly $5,000.00 away from electric lines. I purchased my system two months before the tax benefits evaporated in 1985, and have been enjoying the reasonably free 12V power ever since. I use four 40 W Arcos, mounted on a rack built from salvaged aluminum channel for $9. Storage is 750 ah--six 6 V golf cart deep cycles wired in series and parallel. The house is wired with 10 gauge two conductor wire, with seven runs to keep length and voltage drop to a minimum. Total system cost two years ago was approximately $1500.00. Module output has increased since then, and cost has dropped slightly.

There is a 5000 W AC generator which I use to run the power tools in the wood shop. Until very recently that generator also served to pump water uphill to a 100 gallon storage tank for gravity feed into the house. But the pump unfortunately froze and broke about two weeks ago, and I am currently in the process of installing a 12 V DC pressurized system. I may report on that system if it works out well. Also under construction is a 5 hp 12 V DC generating device. Your last issue's information on the controller was greatly appreciated.

Everything in the house is 12 V, including color TV and VCP (player, not recorder), computer and monitor, stereo, incandescent and fluorescent lights, home-made ceiling fan and blender, soldering iron and tiny vacuum.

Solar hot water back up is Aqua Star demand-type propane hot water heater. Inexpensive and wonderfully efficient. This summer I took the plunge and installed a SABIR propane refrigerator. Frozen daquiris for the first time in years! The hot water heater, my tiny four burner stove, and the fridge should run for two years on the two hundred gallons of propane now in the tank.

My home situation is somewhat unusual. I am a Physical Therapist and commute 30 miles to my clinic. I work there Monday/Tuesday, and Thursday/Friday, so I am home only Wednesday, Saturday, and Sunday. Because of this infrequent use of my system, I have ample energy for my needs. However, I discovered the edge of the envelope this winter when after fifteen days without sun, and after numerous long nights playing new Infocom computer games, I drained the system voltage to the point of shrinking image on the computer monitor. I am constructing the 12 V generator to avoid future energy shortages.

Here are a few tidbits of information.

INCANDESCENT LIGHTS. Best and brightest: quartz-halogen bulbs. Cheapest are 20 W 12 V JC Whitney at $4-5. Don't spend the money for the fixture they sell, just use regular lamps. The bulbs have really unusual bases, so I solder a couple of wires directly to the bulb base, and to a screw mount base from a broken 110 bulb. Ten minutes of work, and cheaper than $7-9 adaptors. Clean the bulb with alcohol to get off finger oil before turning it on.

In my house, I have used RCA-type phono jacks for my electric plugs and sockets. They are cheap, especially in quantity, and are relatively easy to wire. They are just a bit delicate, however. Emerson makes a 12 V Video Cassette Player (not recorder). It's inexpensive ($165 at a local Wal-Mart) & sturdy.

I take exception to your advise to go with a 110 V computer. If one is not absolutely wedded to the idea of the MS/DOS environment, there is a marvelous alternative in the Laser 128. This Apple-compatible computer that is rugged, inexpensive, and operates marvelously on 12 V. It is available through various mail order outlets in its standard version for as low as $365, or in its souped-up 128EX version with extra memory capability and faster clock speeds for $495. I have carried mine back and forth over rough roads in my truck twice a week for almost a year and a half with little problems. Check a recent Apple-type magazine for ads.

The other optimum 12 V computer is the Apple IIc. Both it and the Laser just need to have a 7 pin DIN plug input. Manuals give the wiring configuration. These computers will pull no more than 1.5 A, on the average. More disk access will up this average somewhat. A monochrome monitor may use between 1 and 1.5 A. This isn't much drain.

Some computer monitors operate on 12 V. I have seen ads in the surplus catalogs for 12 V monitors for as little as $25.00. And some 110 V standard monitors actually operate on 12 V circuitry. The Samsung monochrome 12" monitor I use is a 110 V device. On inspection of its schematic, it was discovered that its circuitry actually utilized 12 V via a step down transformer. I made two small solder connections, and Voila!, 1 12 V/110 V monitor. The only problem is a 12 V printer. I know of only one, the DICONIX, made by Kodak. It costs an arm and a leg, so I don't have a 12 V printer. I'd love to hear of an alternative.

Finally, here are some useful references: Best and foremost if you are going to do anything with DC electricity is Michael Hackleman"s "Better Use of... Your Electric Lights, Home Appliances, Shop Tools--Everything that uses Electricity".

JC Whitney's Catalogs. Get on their mailing list and especially watch the semi-annual clearance catalogs. Quartz halogen bulbs are cheapest during clearance sales about $4.00 each. Also occasional deals on alternators (I just got 55/60 amp rebuilt $19.00), 12 V pressure pumps, & lots more.

Electrical Independence Booklets. Available from some alternative energy dealers. Good info on panel mounting, making a DC generator, converting appliances, etc.

Various Alternative Energy catalogs. Spend the money. Many are packed with information and it pays to shop. The money saved by comparison shopping will amply repay the investment.

Surplus electronics catalogs are a storehouse of dc whatamacallits and thingamabobs. Fans, motors, relays, plugs, jacks, computer parts-- you name it. And all cheap, cheap, cheap. If you can use what they've got, you'll save a bundle.

I am sorry to have gone on so long. But maybe an idea or two will be of worth to somebody. If there is some small part of this that you would like to use in your newsletter, be my guest. And if not, I was glad to tell you a bit about my situation, anyway. I'll be glad to answer questions if people include a stamped, self-addressed envelope.

Rick Goodie
RT5 Box 137
Huntsville, AR 7274

GREAT MAGAZINE. Informative, instructive, and a great source of all around information on alternative energy sources. I would gladly subscribe to this magazine should it become nationally circulated. I also have friends interested in alternative energy sources. Please send an extra copy of Home Power.

Thank You, Brad Hunter, Los Angeles, CA

Editor: We do have national circulation and we are also building an international circulation. Tell your friends to fill out the extra subscription form we've provided in each issue or simply write their request with name and address on paper and send it to us. We will be happy to add their names to our mailing list.

Letters

Have read and reread all three Home Power issues. They are GREAT. Although our underground home is served by public utility power, our belief in solar power is such that we have two distinct and separate Solar AE systems in operation.

An AE Solar powered stand alone system furnishes AC power for all tools, lights, etc. in our furniture refinishing workshop. An AE Solar powered Grid-Tied system is installed on the house which provides a portion of our domestic electrical needs. Currently up to 5KW of utility quality 240 volt AC power per day has been generated and fed into the public utility grid through a separate meter. While systems of this type currently have a fairly long payback, it does demonstrate that AE can be integrated into homes that are served by public utility power. As non-renewable resources continue to dwindle and utility costs continue to increase, systems of this type will become more popular.

Warren & Bobbie Webbeking, Prescott Valley, AZ 86314

Hello, we've been homepower people for a decade, and as I'm too tight to spring for a good book, I've based my "system" on rumor. I'm sure you can help civilize me. We have 2 panels, 5 mismatched batteries, our new house under construction (hah, 4 years now) too many children, and a death wish.

Please send #1 if you have any left. Enclosed is the only 2 dollars we have left in the world as our fishing boat just sank.

As much as I abhor nostalgia, your rag brought an early seventies tear to my crowsfeet. Please no articles on channeling & crystals.

Love, Daniel, Daphne, Orla, Kila, Cat, Mako & animals

Barbarian Enterprises, Monhegan Island, ME

I presently receive about 15 magazines, but this was the first issue of any magazine that I read from cover to cover, including ads. I have included a small donation. Could you please send me issue #1. I would like to see an article on the care and feeding of batteries and something on how to start small and gradually build up to a full blown system.

Alfred Judd, Gardnerville, NV

Keep it coming! Please get advanced info on 12 volt audio. Tascan (TEAC) makes a 12 volt Mini Studio 4 track cassette deck for musicians, I have one, it's Great!

How about an article about hooking up power boosters to boom boxes, 12 volt stereo, etc. for us backwoods, sun powered rock and rollers. Great mag, best of luck. I love it!

John Condon, Decorah, IA

This is the first publication I have ever read that has good, useful information on alternative energy. I have stacks of magazines & books on the subject that seem to be written by people who have no first hand experience in the field. Thanks for the magazine we've all been waiting for!

P.S. I recently purchased 2 Kyocera PV's to compliment my single ARCO panel I've had for a year. And I'm luxuriating in lots of 12 VDC fluorescent light & super running AC appliances with my shiny new Trace 612.

John Blittersdorf, Pittsford, VT

I'm very interested in solar & wind power systems. I would like to get a local group together to discuss different ideas and how these systems work.

Brian J. Lea, RT1 Box 375 H Valley Rd., Honor, MI 49640

What a wonderful effort. Thanks! I like your philosophy and your intentions. Perhaps an extension of ideals about energy could parallel the meta-physic: that energy gained must be exchanged. Don't knock yourselves out on a monthly that will transform you into burnouts and us into blase. Make it fuller, less often, and by fair exchange to the receiver. How about... Quarterly for 5 bucks with lots of space for specific or site responses. I mean really! Get a charge for your voltage.

Furthermore and in any case, we here in the oldest hills in the world (Grandfather Mtn.) are glad to see you're there. Lots of us are.

Ya do layout on a Mac, you rascals!

Mark Tomlin, Boone, NC

Q&A

We try our best to directly answer all your questions. Please remember that we are limited by our own experiences. If we don't have the direct personal experience to answer your question, we won't. We'll print the question anyway and hope that a Home Power Reader will have the experience to answer it. So this column is not only for questions to Home Power, but also for answers and comments from its readers. We try to answer as many questions as we can. Fact of the matter is that for every one we print, there are about 10 we don't. It's a matter of space. Hopefully, we will be larger soon and can deliver all the fine material that forlks have sent in. Thanks for your patience-- Rich

---

What about thermovoltaic energy? Can electricity be made from the heat of a wood stove as rumored?

Ken Zimmerlee, Wauconda, WA

Yes, heat can be converted directly into electricity by a process known as the Peltier effect. Hot to cold differential causes free electrons in some very special materials. This process is similar to the photoelectric effect that's employed in PV cells. I've heard rumors that there are prototype Peltier effect generators working, but that longevity and efficiency are still problems. Anyone using these devices, please write Home Power central and let's set up an article about direct heat to electric conversion. The wood burning stereo has long been a fantasy of ours.

Will a 10 amp trickle charger work to charge deep cycle batteries off of a 120 volt home circuit?

Patty Dillberg Santosha, Kaunakakai, HI

Sure, if you leave it on long enough. Ideally, it's good if the charger can deliver at least a C/20 rate to the battery. However, charge rates as low as C/100 can be quite effective at recharging and even equalization, if they are left on long enough.

Many of my appliances have adaptors which go from 120vac to 12 or 6 VDC. When calculating my power consumption do I consider these appliances as 120 vac or 12/6 VDC. Please address this issue for me as I have not been able to locate this information anywhere as yet. Thank You.

Rolf Mueller Plainfield, VT

If you are using the 120 vac adaptor, then calculate its power consumption as a 120 vac appliance. If you have converted the appliance to direct DC use, then treat it as a DC appliance. Many small appliances can have their efficiency greatly increased by putting them directly on DC rather than using their ac adaptors.

We built a small (4 ft.) overshot wheel connected to an old shallow well pump that our creek powers 9 or 10 months a year at 1 to 2 gallons a minute. We would like to know if a car alternator could be hooked up to the wheel in the winter to trickle charge a battery bank?

Stephen & Cathy Posavatz Hornbrook, CA

Yes, this can be done. The problem is that most alternators like to run at high RPM, while your water wheel travels at very low RPM. In many cases, the belts and pulleys (or gears) required to raise the RPM of the system waste so much power that the system barely produces enough surplus energy to recharge batteries. I've seen setups like you described which can produce about 1 to 3 amperes at 12 VDC, and this amounts to around 400 watt-hours daily.

I would like to find out how to rebuild or recondition lead acid batteries. Do over the counter chemicals do anything they claim? Do they prolong the life of new batteries? Keep up the good work.

Frank Forseilles, Dolan Springs, AZ

We'd like to have this information also. I've no direct experience with the chemical battery additives. Help! Home Power readers with this knowledge, please check in.

Can the voltage meter circuit (HP #2) be adapted to a 24 volt or higher system? Can you show us one to measure AC current also? That would be a great help for me and many others I am sure.

Robert Wise, Showlow, AZ

The meter circuit in HP#2 will work well in 24 VDC systems with some minor changes. Use the original schematic, but make the following changes. On the voltage divider feeding pin 5 of the LM 723, change the top resistor from 10 KΩ to 51 KΩ, change the pot (R1) from 2KΩ to 5KΩ, change the lower resistor from 22kΩ to 24KΩ. On the series resistor string feeding the plus side of the meter, change the 3.3 KΩ resistor to 9.1KΩ. On the resistor connecting pin 11 of the LM 723 to Vcc, change it from 1KΩ to 2KΩ. Adjust R1 so that the test point measures 22 VDC. Adjust R2 until the meter reads properly. The finished meter will start reading at 22 VDC and will be full scale at 32 VDC. This is the operating range for a 24 VDC lead-acid system. Circuits for measurement of current, both ac and DC will be forthcoming in future issues.

I have a Honda 350EX. Any suggestions on how to quiet it a little more? Can a muffler/exhaust port attachment be put on safely to extend the exhaust for diversion of gasses & quieting? Does this cause any problems with back-pressure in the exhaust manifold?

Hal Zimmer, Issaquah, WA

First thing to try is your Honda dealer. In many cases they make extra quiet mufflers for their models. You can use the muffler/exhaust port attachment to attach a better home made muffler. The trick is not to hang a lot of weight on this port, but to brace the muffler assembly elsewhere. Allow for expansion and contraction of the muffler assembly.

Excellent on battery storage in last 2 issues. I would like a clarification: you seem to imply with the limits of a C/20 charge rate and reliability constraints of internal resistance that large autonomy - 10 days or more - is impossible. Am I missing something?

Steve Smith Swanlake, ID

Long term energy storage in lead-acid batteries is not impossible, but it is inefficient. Consider that the high antimony, lead-acid batteries most suitable for home power use have a self discharge rate of about 6% of their capacity weekly. A pack that stores energy for 4 weeks would lose about 25% of its energy to internal action. Nicad systems do about 3 times better. We size our engine/PV systems with at least 4 days of storage, but with no more than 10 days storage. It is more cost effective to run the engine during expended cloudy periods than to increase the capacity of the battery pack.

Q&A

So far, the generator seems to be the best way to bring batteries up to peak charge. I would not like to be dependent on gas, so would you have any advice for bringing the batteries up to some semblance of peak charge?

John Roshek Weed, CA

You can completely fill your batteries with any energy source you have available. A gas generator is cheap and its power is available when we want it. Oversize your PV system to produce about 10% to 20% more energy than you're consuming-- this will keep your batteries in tip top shape. Batteries love Hydro inputs because they are constant, so develop any Hydro potential that you may have. We are all doing all we can to wean ourselves of fossil fuels. Right now we are forced to make some hard decisions, basically due to the cost of PVs. As PVs become even less expensive, we are looking forward to kissing our engines completely goodbye.

Two things I'm interested in - low power water pumping (shallow well & using a pressure tank) either 12 VDC or 115vac and 12 VDC color TV's. Is there anything made with a screen larger than 12 inches?

Lisa Reynolds Pearson, WI

We are working on a PV powered water pumping article right now. Contact Flowlight Solar Power, POB 548, Santa Cruz, NM 87567, and ask Windy Dankoff about his PV powered pumps and PV powered booster pumps. They work, are well made, and are worth more than he charges for them. In terms of 12 VDC color TVs, the ones I've seen are all small (<12 in.). Anyone out there using larger screen TVs on low voltage DC?

REGARDING HP3 PAGE 45 DURGA TAMM

Marine catalogs have a variety of 12 VDC stereo equipment, i.e. Cybernet #CMS54050 65 watt booster amp & 5 band graphic equalizer. P.S. I also dropped a note to D.C. Tamm.

Walt Cunningham Port Bailey, AK

All right, a Home Power reader delivers the info! Thanks for sharing. If anyone has answers to the questions seen in this column, please feel free to contribute. We do the best we can with what we personally know, but we don't know it all by a long shot.

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Where Are We Going? Clearly Downward, Backward, Then Forward!

J. Michael Mooney

Downward
The voltage and current requirements for our homes and offices are plummeting. The magic of "solid state" has pervaded our every building, vehicle, and machine, making power sippers of power guzzlers.

Fluorescent lighting has reduced our home and office lighting requirements by a whopping 80%. We are in the process of ridding ourselves of our last two vacuum tubes, those are the cathode ray tubes in our TV sets and computer monitors.

Technology advances are bringing us an endless stream of electrical equipment with previously unheard of efficiency and performance. We have come to accept, indeed even expect, an "AC Adaptor" with each new appliance we buy. An "AC Adaptor" tells us that the appliance operates at a voltage level between 1.4 and 12 volts, efficiently using only a sip of the 120 volt power coming from a wall socket. Cordless appliances and tools are now in their second wave with amazing performances, durations, and selections.

Backward
Just over a hundred years ago, when Thomas A. Edison invented the electric light, there was no electrical system to power it. Edison then pounded out the basic technology for a DC power system with efficiencies in the 90% range.

Edison's DC system lost out to AC as the latter was more conducive to transmission over long distances. Edison lost the battle, but, he is about to win the war. We are going back, over a hundred years back, to Edison's starting point. We are in the process of re-discovering our mentor.

Forward
To say that the near term future for alternative energy is exciting would be the epitome of understatement. Most of us reading this publication own and operate low voltage, cordless homes and offices.---"No AC adaptors required."

In less than 10 years time, millions will be living in extremely comfortable homes which will consume less than 6 KWH of electricity per day. Our operating voltages will be a non electrocuting 24 volts DC for major appliances and 12 volts DC for portable appliances (10% of present levels.)

THE ON SITE, PERSONALLY OWNED, PV ARRAY WILL BE THE SOURCE OF POWER.

MURPHY'S NOTEBOOOK

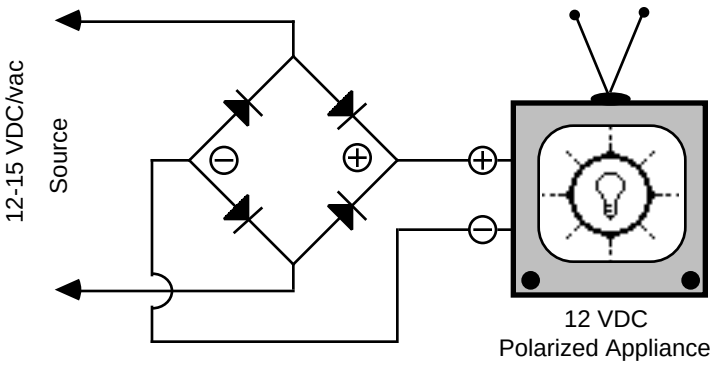
Connect It Backwards- And Zap It!

J. Michael Mooney

Amazing technology advances are bringing us a whole new world of low voltage and cordless appliances to operate directly from our battery storage. Murphy was waiting with his law that says "The more it costs, the greater the probability that reverse polarity will destroy it".

You might want to make use of this automatic, solid state polarity sorter to save those expensive devices. It will beat you to the draw, no matter how quickly you can hook things up backward. Available everywhere, a 10 amp, 50 volt bridge sells for about $2.50.

The bridge will introduce two diode drops (1.4 volts) in the DC line, a low price for the protection gained. This drop may be substantially reduced by constructing your own bridge from Schottky diodes.
THIS BRIDGE MUST BE PROPERLY RATED IN TERMS OF VOLTAGE AND CURRENT, AND MUST BE PROPERLY INSTALLED OR MURPHY WILL GET ANOTHER "GOTCHA."



Choosing Components for a Hybrid PV/Gen System

Sam Coleman

The PV/gen system is one in which the PV input is optimized for energy usage and backed up by a generator/battery charger system. The necessary parameters for determining the components are as follows:

1. AC inverter usage in watt-hours per day
2. Priority ac inverter usage, i.e. the maximum wattage used at one time in watts.
3. Priority ac inverter surge, i.e. maximum surge wattage expected at one time in watts.
4. DC usage in watt-hours per day.
5. Number of days of battery stored energy needed.
6. Average solar insolation for your location.
7. System efficiencies.

Inverters

The inverter that is chosen must satisfy two of the above parameters. First its continuous wattage rating must be greater than the priority ac wattage. Second, its surge rating must be greater than the priority ac surge wattage required. The inverter chosen on this basis will determine your battery pack's voltage.

Battery Pack Sizing

The voltage of the battery pack is determined by the required DC voltage input of the inverter. The capacity of the battery pack is determined by the total usage (both ac and DC), the number of days of storage required, and the battery pack voltage. This can be determined by the following equation:
The factor of 0.9 relates to inverter inefficiency, while the factor 1.25 represents discharge to the 20% state of charge on the battery pack.

$$BPC = \frac{\left(\frac{ACU}{0.9} + DCU\right)}{BPV} \quad (NDS)\ (1.25)$$

BPC = Battery pack capacity in ampere-hours
ACU = ac usage in watt-hours per day
DCU = DC usage in watt-hours per day
BPV = Battery pack voltage in volts
NDS = Number of days of storage needed

PV Array Sizing

The sizing of the PV array depends on the amount of sunshine at your location, the total usage (both ac and DC), the efficiency of your system. Here we must make some assumptions. First, let's assume that the average daily efficiency of your system is 80%. It may be more or less depending on the percentage of energy use directly from your panels. Let's further assume you are going to use 36 cell panels with a short circuit current rating in the neighborhood of 3.1 amperes, and that you average about 8 hours of sunshine on sunny days. For this situation a good estimate for the output of a single panel is 20 ampere-hours per day. Optimum PV array sizing is then determined by the following process.
First determine the array capacity.
Next determine the number of panel sets of proper voltage.
This number should be rounded off to the next highest integer.
Then determine the number of single 12 volt panels necessary.

Generator/Battery Charger

The battery charging device may be a DC engine/alternator or an ac generator/battery charger system. In either case it should be capable of producing a C/20 rate of charge up to at least 16 volts DC. A C/20 rate in amperes is equal to the battery pack capacity divided by 20. If a DC system is used,

$$COA = \frac{\left(\frac{ACU + DCU}{0.8}\right)}{BPV}$$

COA = Capacity of the Array in A.-hrs/day
ACU = ac usage in watt-hours per day
DCU = DC usage in watt-hours per day
BPV = Battery pack voltage in volts

$$NPS = \frac{COA}{20}$$

NPS = Number of Panel Sets
COA = Capacity of the Array in A.-hrs/day

$$NPN = \frac{NPSR\ \ (BPV)}{12}$$

NPN = Number of 12 V panels needed
NPSR = Number of panel sets rounded from previous equation
BPV = Battery pack voltage

one is limited to maximum inverter wattage for ac appliances. If, however, an ac charging system is used one can size the generator so that when charging is taking place there is enough left over energy for high wattage ac use. High wattage intermittent use of ac appliances should be run off the generator for best efficiency. These appliances might include such things as table saws or washer/dryer sets. These should NOT be included in the inverter ac usage figures.

PV Array Regulation

For the above system in normal everyday usage regulation is not necessary. This is because the energy is being used either to fill up the batteries from the previous night's use or being used directly during the day. However, regulation can become necessary when vacation time comes around or if one must go away for a few days. The best way to deal with this is to wire the array to the system in two or more segments. One segment is wired directly to the battery pack and should produce no more than a C/100 rate. The other segments should be wired through high amperage switches. If you go away on vacation just fill up the batteries before you leave and disconnect the switched PV panels.The battery pack will then coast at a C/100 rate very nicely. If sudden emergencies arrive and one does not have the time to charge up the pack, more segments can be left on line, the number depending on the amount of time one expects to be away. The set up also allows parts of your array to be switched from ordinary use to special use easily.

Also, just to be sure, you should have an on line voltmeter so you can watch the battery's voltage. Then you can switch off the panels if the voltage gets above 15 volts.

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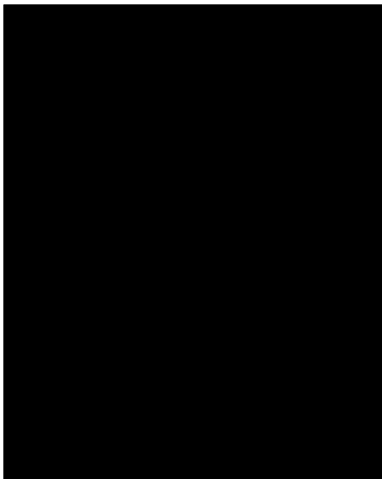

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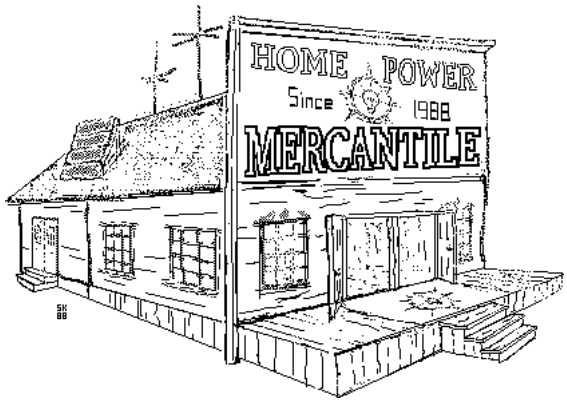

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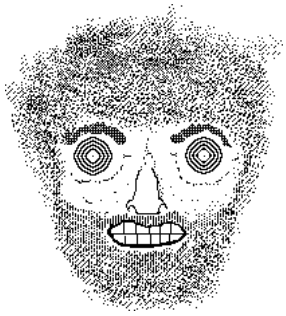

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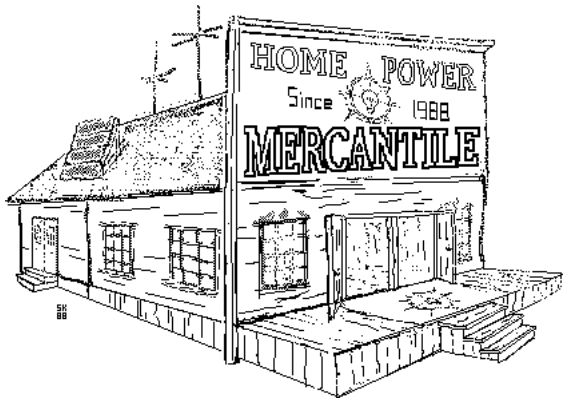

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