



# Battery Rack Design & Construction

Mike Brown

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In the last issue, we talked about battery layout, and finding out how many batteries will go where. We determined how much space was needed for the batteries, the battery box, and the battery rack. Now we will take our two-dimensional length and width layout and add a third dimension—depth. We will pick the material to build the rack with, and determine how to fasten the rack to the car.

## Suspension Racks

First let's look at the type of battery rack that is sunk into the floor of the trunk or hatch area, under the back seat of the car, or between the frame rails of a pickup truck under the bed. I call this type of rack a suspension rack because the weight of the batteries is suspended between the top of the rack, where it is attached to the car body by its flange, and the bottom of the rack, which is unsupported. This type of rack is shaped like a basket, with a flange around the top edge, and vertical supports extending down to the base.

The amount of depth to be added to this rack is limited by the amount of ground clearance needed to permit driving over all the various dips and bumps found on the streets. Another issue to consider is the pavement's angle of departure, or how abruptly it shifts from flat to uphill or downhill. How steep a driveway can the car be driven up before the bottom of the battery rack scrapes on the pavement?

The rule of thumb I use is that no part of the battery rack should be any lower than the lowest non-movable part of the rear suspension. This rule has worked well for me over the years. The rack won't bottom out, but it still carries most of the batteries' weight below the floor level of the car. This is a very important safety factor in case of a collision.

My material of choice for battery racks is 1/8 inch (3 mm) thick steel angle stock. Depending on which type of rack it is, the size (width of the arms) of the angle stock varies from one to two inches (25–50 mm) wide. The size of the angle stock is determined by where it is used in the rack.

For example, the base of our Voltsrabbit rear rack, which supports eight batteries and their box, is 1-1/2 inch (38 mm) angle stock. The top of the rack is 2 inch (50 mm) angle stock. This provides a wide flange where the rack meets the floor of the car and gives space for the 1-1/4 inch (32 mm) fender washers with the nuts and bolts to fasten the rack to the body.

The distance from the surface that will support the flange down to your needed ground clearance determines how deep the rack will be. The tops of the batteries and battery box may extend a few inches

**A suspension rack installed in a hatchback.**



above the flange at the top of the rack. The top and bottom of the rack are held together at the proper distance by four pieces of 2 inch (50 mm) angle stock at the corners of the rack.

The corners are butt-welded to the edges of the top and bottom angle stock. Additional strength is added by welding 1 by 1/8 inch (25 x 3 mm) flat stock straps to the outside of the angle stock from top to bottom at the center of each side of the rack. If the rack is a large one, the bottom can be reinforced with a piece of 1-1/4 inch (32 mm) square tubing running from side to side under the center of the rack.

It's necessary to have each battery in the pack supported on at least two edges by the rack, even if the batteries are in a box. It is very important to size the material of the rack top and bottom, the corner pieces that hold the top and bottom together, and any reinforcing straps used between the top and bottom to suit the weight the rack is supporting. Attention should also be given to the number and type of welds holding the rack together, and their weight-carrying ability.

If you are not an experienced fabricator and welder, it might be best to bring a professional welder in at the start of the rack design to help determine material size and design for ease of assembly. What you pay for design help will save you money when you start fabricating the rack, and will eliminate the possibility of failure due to a weak design.

### Bridge Racks

Now let's look at the type of rack that would be found in the former engine compartment of a car or truck. I call this the bridge rack because it carries a load (batteries) over a gap (the space above or around the motor) and is attached to an abutment (the frame or body of the car). This is also the type of rack you would use in a VW bug if you were going to put batteries where the back seat was.

Instead of a basket shape, this type of rack is more of a tray with a lip around the edges. It needs to be paired with a matching hold-down frame that secures the tops of the batteries.

In my last column, we determined how many batteries we are supporting and where we are putting them. We proved that we can close the hood over them safely (the depth dimension again) by taking

measurements and building mock-ups. Now we can proceed with the design of the rack.

The materials remain the same—angle stock in 1 or 1-1/2 inch (25 or 38 mm) widths. Which size to use depends on the number of batteries the rack is supporting and the distance it has to span without support. If any tube or angle stock is added to the underside of the rack for battery support, make sure it doesn't interfere with any other part of the car, like the motor or transmission.

Most front engine/rear wheel drive cars and trucks have a large open space where the engine was. The boxes and racks that fill those spaces tend to be rectangles of varying sizes. The front engine/front wheel drive cars have a differently shaped space for batteries because the transaxle remains in the engine compartment after the engine is removed.

This results in a battery space that is L-shaped, and often the batteries in the base of the L are lower than the batteries in the upper part of the L. This split-level space situation can be handled with separate upper and lower racks, or a one-piece split-level rack. Which alternative to use depends mainly on the availability of places to mount the racks to the car. The bridge-type rack presents some choices, but the layout still comes down to rectangles of varying sizes.

### Floor Racks

The third type of battery rack we are going to discuss is called the floor rack. This kind of rack is found in van-type vehicles, usually under or between the seats. It is also found in pickup trucks where the batteries are put

**A split-level bridge rack supported on the right by the original bumper bracket bolts, and in the rear by the mount plate on the firewall.**



in a box in the bed instead of boxes and racks under the bed. It could also be used in a hatchback-style car where sinking the rack is not possible. In short, this rack works anywhere there is a perfectly flat floor to set the rack on.

This type of rack is almost always a large rectangular tray with ten to twenty batteries in a box. Since the rack is fully supported by the floor of the vehicle, 1 inch (25 mm) angle stock is strong enough for the perimeter. Flat stock should be added to support the floor of the battery box where the edges of the batteries meet. Supporting the weight of the batteries is not as big a problem with this rack, but mounting the rack to the floor and securing the batteries and battery box to the rack is a challenge.

### Attaching Suspension Racks to the Chassis

The primary job of the battery box and rack system is to keep the batteries secured in their place and isolated from the passengers. How the battery racks are attached to the car's chassis or body is a crucial part of the battery rack's design.

Attaching the suspension-type battery rack to the car's body is made a little easier by its position in the body. Because it is in a hole in the floor of the car's body that is only a little bigger than the outside dimension of the rack, it is well confined in the front-to-back and side-to-side directions. Since most of the battery pack's mass is below the level of the car's floor, in the event of a collision, the batteries will stay below the floor.

All of the good news mentioned above does not eliminate the need for fasteners. Our Voltsrabbit's sunken rear rack is held in place by twelve 1/4 inch (6 mm) bolts. The bolts go into holes in the rack, through holes in the body. Under the car, a 1-1/4 inch (32 mm) diameter fender washer is placed over the bolt and a 1/4 inch nylon locking nut is threaded onto the bolt.

This may seem like too few bolts of too small a diameter, but shear forces (forces that are trying to cut the bolt in two across the diameter) on the bolt are limited by the close fit of the rack to the hole in the body. In a collision, horizontal forces would not be carried by the bolts alone, but would be distributed along the entire angle stock flange where it meets the body.

Under tension (where the forces acting on the bolt are trying to pull it apart lengthwise), the tensile strength of the bolts combined with the amount of contact between the rack's flange, the car's body, and the fender washers keeps the loads within safe limits.

The practical proof of these statements is the fact that the rear of a Voltsrabbit can be lifted with a floor jack

using the reinforcing bar on the bottom of the battery rack as a jack point. This is done without any distortion of the body around the rack or any damaged bolts. Since our car is torn down regularly for classes, we have been able to check for any damage or distortion from the forces encountered in long-term use. In nearly ten years, we have found none.

If your suspension-type rack is holding more than eight batteries, you could go to a 5/16 inch (8 mm) bolt. Always use as many bolts as you can place around the perimeter of the rack at 6 inch (15 cm) intervals and have body metal under them to fasten to. When you are ready to install the rack, place it in the hole, clamp it in place, and spot drill through the holes in the rack to locate where to drill the holes in the body. Use a felt pen to mark the outside edge of the rack's flange. Remove the rack, and finish drilling the holes.

You may have to drill through a thin sheet metal frame member on a unibody car to bolt the rack to the car. If so, run the bolt through a pipe spacer inside the frame member to prevent crushing the frame when you tighten the bolt. The spacer should be as long as the depth of the frame member it is going into, minus the thickness of the metal the frame member is made of. Try to get this dimension as close as possible. Too long a spacer will keep the rack from being tightly fastened to the frame member. Too short a spacer will result in the frame member being crushed. A little too short is better than too long; a little crush is all right.

To install the spacer, drill holes to fit the bolt size through both the top and bottom of the frame member. Next, drill the bottom hole to the size needed to allow the spacer to enter the frame member. When you are ready to do the final installation of the rack, apply a thick bead of silicone caulk to the top of the body between the edge of the hole and the felt pen mark you made earlier. Put the rack in the hole, and line up the bolt holes in the rack and the body. Install the bolts in their holes, using longer bolts where needed to go through the frame member.

From the underside of the car, install the fender washers and nylon locking nuts on the bolts, and tighten securely. When you get to one of the bolts that needs a spacer, put the spacer over the bolt, install the fender washer and nylon locking nut, and tighten as before.

When these steps are completed and the battery rack is securely attached to the car body, any chassis stiffness lost by cutting the hole in the car's floor is replaced by the battery rack. Installation of a suspension-type rack in a pickup is a similar process. The truck frame, however, is much thicker than a car's sheet metal floor,

so the bolt hole spacing could go out to 8 inches (20 cm) apart, the bolt size could go up to 5/16 inch (8 mm), and there is no need for the fender washers.

### **Attaching Bridge Racks to the Chassis**

How difficult it is to install a bridge-type battery rack depends on the number of mounting points available on the car's chassis. You need to find a place to make your attachment. Then design a welded extension to your rack to reach the attachment point. The first thing to look for is an existing bumper mount whose bolts could also be used for a battery rack mount.

Motor mount bolts can also be used, even if you are still using them to mount the electric motor. A non-moving part of the suspension, such as an upper shock absorber mount or suspension pivot mount, can be used. But it must be strong enough to take the load you are adding plus the existing load.

You will probably have to substitute longer bolts to make up for the thickness of the mount you are adding and still have the same amount of thread engagement as the original bolt did. When substituting bolts, be sure to get the same thread pitch, size (diameter), and class of hardness as the original bolt.

You may be asking yourself, "Now, what do I do? I've used the front bumper mount bolts to support the front of the rack, but at the rear there are no ready-made places to attach the rack to." In a unibody car, this can be a problem. If there is a welded sheet metal frame member that would support a rack mount, you could use the long bolt and spacer method described above.

If it looks like all that you have to attach the rack mount to is the vertical sheet metal firewall, it's time to make a sandwich. It's not edible, but it does give strength to a thin steel firewall by distributing the loads from the battery rack over a larger area of the firewall and stiffening the firewall at that point.

This type of mount consists of a flat steel plate 1/8 inch (3 mm) thick welded or bolted to the rack. This plate should be as big as it can be and still fit against a flat spot on the firewall. There are a number of 1/4 inch (6 mm) holes drilled in the plate. An identical steel plate, the same size and shape with the same number and location of holes, is fabricated at the same time. This plate is the backup plate, and it goes inside the car on the opposite side of the firewall from the mount plate.

Sometimes it can be difficult to hold the backup plate in place while threading a bolt through both plates and the firewall and tightening a nut on it. In this situation, I weld a nut to the backup plate, which gives me what is called a captive nut.

When the rack is installed and bolted to the other mount points, the mount plate is held in place against the firewall by the other mounts. Then the locations of the holes in the mount are transferred to the firewall by spot drilling through the holes in the mount. The rack is removed, and the holes are ready to be drilled the rest of the way through the firewall. Before you start drilling, it is wise to check to make sure that there are no vital components like heater cores, wire bundles, or electrical components where you are going to be making holes.

Install the rack for the final time, securing the other mounts loosely for now. Line up the holes in the sandwich mount with the holes in the firewall. Have an assistant inside the car hold the backup plate in place and line its holes up with the mount and firewall holes. Now insert the bolts through the three holes and secure with the nylon locking nut.

If the backup plate has captive nuts, I have found that it is easier if I line up one set of holes by inserting a small punch through all three pieces. Then I have an assistant move the plate until I can thread one of the bolts through one of the other holes and into one of the captive nuts. Thread the remaining bolts with lock washers into the backup plate captive nuts, and tighten them enough to hold the plate in place. Then remove the punch and install the final bolt and lock washer.

The small pickup trucks that are converted are of the body-on-frame type of construction, which offers its own set of challenges. There are few mounts or existing bolts to use to help mount the battery rack. There are, however, two heavy frame rails that could have rack mounts bolted or welded to them. The design of these mounts might be another place where a consultation with your welder would be helpful. One word of warning, however. If you weld the rack mounts to the frame, bolt—don't weld—the mounts to the rack. You might need to remove the racks to service the motor, and you don't want to have to cut them up to get them out.

### **Attaching Floor Racks to the Chassis**

The floor-type battery rack could be mounted like the suspension-type rack with a bolt, flange, fender washer, and nylon locking nut system. However, since the loads on the mount come from above the flange, I don't think this system is strong enough. I have seen videos of accidents in EV races where a car went into a wall. When the rack sat on top of the floor and was attached by bolts, washers, and nuts, it tore loose because the washers pulled through the body metal.

The sandwich system, which spreads the load over a larger area, is preferable. The mount plates could be

welded inside the perimeter of the rack to free up floor or bed space. In this case, the mounting bolt holes should be countersunk, and flat-headed bolts should be used to avoid interference with the bottom of the battery box. Mount plates should be placed at each corner of the rack and in the center of the long side of the rack. Be sure to check the underside of the vehicle for interference with the backup plates and nuts.

Both the bridge and floor-type racks have the battery box and batteries sitting on them. In some situations, this means that they should be built with a bottom, sides, and top like the suspension rack, but without the top mounting flange. The sides should be high enough to contain the majority of the batteries' mass like the suspension-style rack. I'll discuss this further next issue when we talk about battery box and battery box hold-down design, as well as protective coatings for the racks.

I have tried to write this with as much detail as space permits, but if I haven't been clear enough or you have more questions, please write, phone, or email me and we will talk about it.

#### Access

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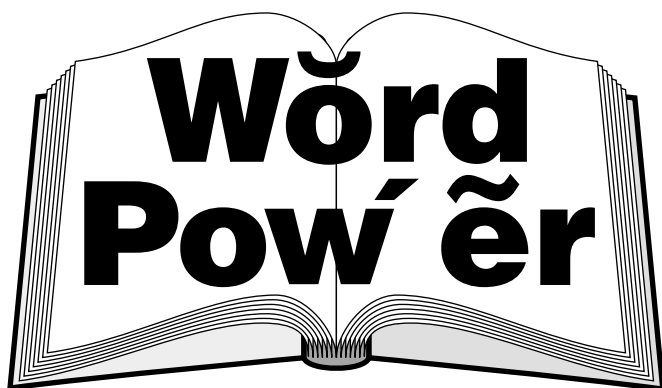
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## Renewable Energy Terms

# Watts = Volts x Amps Power Equation

Ian Woofenden

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**Derivation:** *The watt, volt, and amp are named after three well-known people in the history of energy—James Watt, Alessandro Volta, and Andre Ampere. This equation does not seem to have a formal name, so I'll just call it the "power equation."*

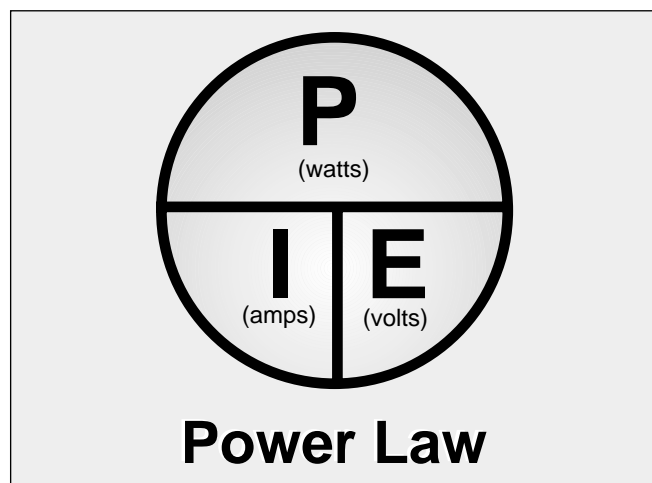
To understand the power equation, you need to understand what power is. Power is the rate at which energy is generated or used. Though no analogy is perfect, energy is like miles traveled, while power is like the rate of travel—miles per hour.

Power is measured in watts. When we see a 50 watt lightbulb, we know it uses energy at a certain rate. Technically, a watt is equal to one joule per second. But the important thing is that a watt is a rate of energy use or generation, not an amount of energy used or generated. Instead of saying "a lot of power," we should say "high power" or "a large value of power," so it's clear that power is a rate, not a blob of stuff. We should never say that power "flows," since power itself is a rate of flow. Energy can flow, but power doesn't.

Two things go into the flow rate of electrical energy. One is the "pressure," and the other is the rate of charge flow. We call electrical "pressure" voltage—it's the push that makes charges flow. And we call the rate of charge flow amperage—an amp is a certain number of charges passing a point in one second.

You might remember from my column in *HP77* that there's a direct relationship between volts, amps, and ohms. Well, there's a similar relationship between watts, volts, and amps (in DC circuits and resistive AC circuits). Take a look at the power equation diagram. Cover the unit you want to solve for, and the remaining

two units will give you the rest of the equation. If one is above the other, divide. If the remaining two are beside each other, multiply.



So there are really three forms of the same equation:

**Watts = Volts x Amps**

**Volts = Watts ÷ Amps**

**Amps = Watts ÷ Volts**

We can use this equation to do lots of common electrical computations. For example, if a motor is drawing 20 amps at 12 volts, we know that it's using energy at the rate of 240 watts (watts = volts x amps). If a lightbulb is drawing 100 watts at 4 amps, we can conclude that the voltage is 25 volts (volts = watts ÷ amps). And if we have a 150 watt lightbulb running on 120 volts, we know that it is drawing 1.25 amps (amps = watts ÷ volts).

We can also play with the values within the equation. If you run a 100 watt lightbulb directly from your 12 volt battery bank, it will draw 8.3 amps (amps = watts ÷ volts). If you run another 100 watt lightbulb through your 120 volt inverter, it will only draw 0.83 amps (amps = watts ÷ volts). The same amount of energy flow results in both cases, but the higher voltage means that the amperage is proportionally lower.

This only scratches the surface of the usefulness of this formula, and I'm glossing over some technical distinctions and exceptions. I continue to find applications for the formula as I learn more about electricity and renewable energy systems, and I expect you will too.

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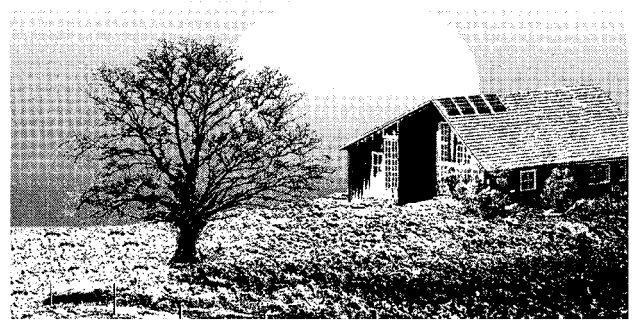
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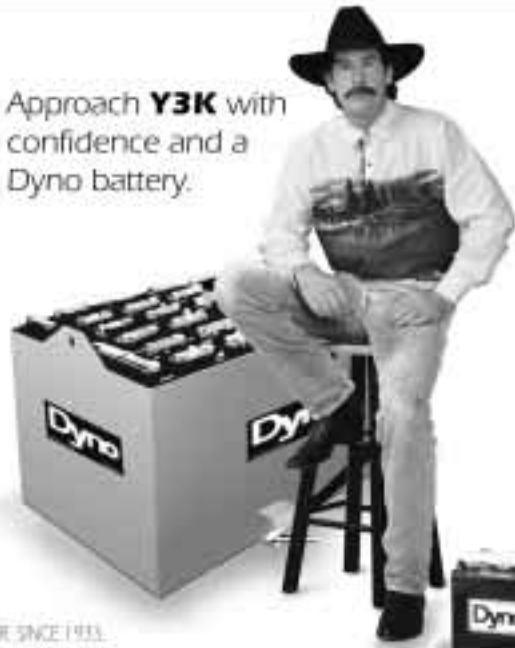
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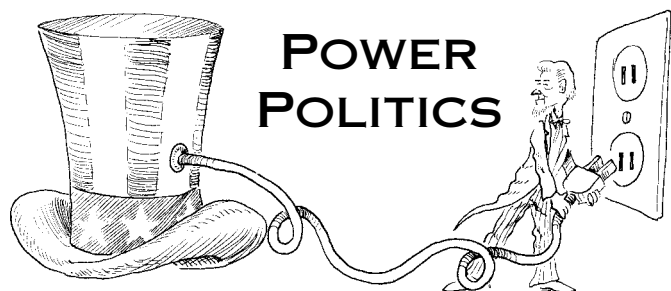


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**W**e are faced with a choice in this November's presidential election. We can vote for someone who is well ensconced in our corrupt political system, or we can vote for a third-party candidate who is not beholden to corporate political puppeteers.

We've had this choice in other elections, so what makes this one any different? There is no conservative third-party candidate that has a chance, but there is Green Party candidate Ralph Nader, who is poised to make inroads into our two-party "duopoly."

Nader is renewable energy's knight in shining armor. He is the only candidate who has dedicated his life to fighting for what is right for the citizenry, as opposed to giving away public rights to corporations. Coal, oil, gas, nuclear, and utility companies are some of the biggest abusers of our political system; Nader is prepared to take them all to task. Nader founded Public Citizen and its Critical Mass Energy and Environment Program to help promote RE, and to get rid of polluting and unsafe energy technologies. He would be RE's ideal President.

## Lesser of Two Evils is Still Evil

Many readers fear that a vote for Nader will ultimately help elect the more conservative mainstream candidate, the worse of two evils. In the 1996 election, that did not matter too much. It was fairly easy to support RE by voting for Ralph Nader because for every vote Ralph sucked away from Bill Clinton, Ross Perot had taken away several others from Bob Dole. The danger of accidentally electing the less desirable candidate by accident was minimal.



Ralph Nader, Presidential candidate.

In 2000, a vote for Nader appears a bit more risky for those concerned about the lesser of two evils. In comparing Gore and Bush from the standpoint of RE, or from just about any other progressive point of view, the difference between the two is visible. Very few potential Nader supporters would come from the conservative Bush camp, whereas Nader's votes could be drawn away from the more liberal Gore. Theoretically, if too many Nader votes come from potential Gore voters, we might end up with Bush, an oil company man, as President.

I'd hate to see that happen, but I also believe that there is not enough difference between the two mainstream candidates' governing capabilities to merit much concern. Sure, there are significant philosophical differences. But when it comes right down to who has access to politicians after elections and who has the most influence, politicians follow the money, which flows from the corporations.

Corporate influence has been slowly homogenizing Democrats and Republicans into a single party of corporate supporters—they might as well be called Republocrats. Since the differences between the mainstream candidates have become seriously reduced, the risks associated with accidentally electing the worse of two evils are also reduced.

### Vote With Conscience & Effect

Co-worker and Libertarian Ian Woofenden suggested another reason for voting for purer third-party candidates instead of the lesser of two evils. He firmly believes that our votes should be counted for what we believe in, rather than acquiescing to marginal differences in candidates. "You continue to get an evil," he says, "and you don't let anyone know what you really want or stand for." This is a good point for sure, and one I agree with. Ian and I also agree that results are just as important as standing on principle. Something needs to change, and the sooner the better for the health of our planet. Nader does have a very slim chance of being elected this time around, but the possibility of strengthening him now for the 2004 election is what finalized my decision to support him.

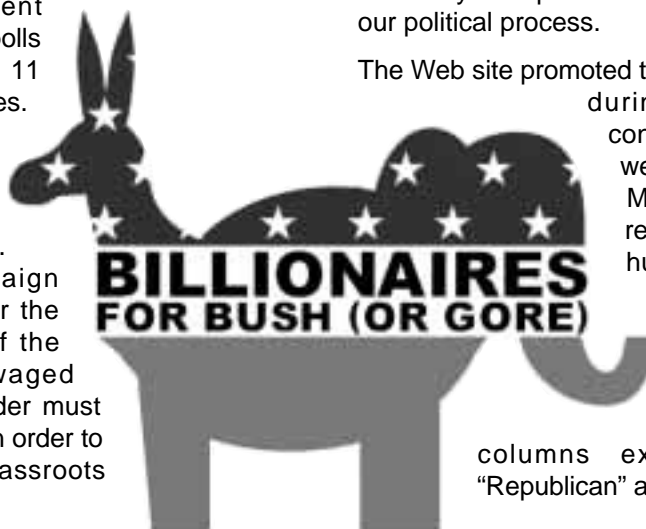
### Get Back the Non-Voters

The Nader campaign does not target Gore voters specifically, but is aimed at those who otherwise would not have voted. They intend to target a "get-out-the-vote" campaign at disenfranchised citizens who have given up voting because they think their voices have not been heard. The Nader campaigners hope for a response from these folks because they say their candidate is different—not a part of the group of politicians representing business as usual.

Once formerly disenfranchised voters start coming on board, it should show up pretty obviously in the polls. If, as a result, the polls and the media show that support for Nader is increasing significantly, many more voters will be willing to jump the Bush/Gore Republocrat ship for the clean candidate.

There was actually a surprising head start for Nader in the polls. A Fox News-Opinion Dynamics poll taken about a week before this writing showed that he had already received 8 percent nationally, and various state polls showed between 7 and 11 percent in their respective states.

But Nader is not assured to be on the ballot in every state—that is the campaign's current push. According to Nader campaign literature, "The real battle for the hearts, minds, and votes of the American people will be waged locally." That means that Nader must make the ballot in each state in order to garner the strength for a grassroots campaign.



The more states with Nader on the ballot, the more credible his candidacy appears to the media. The more credible the candidate, the more likely he will be able to participate in the debates, as Perot did during the last election. If Nader can get into the debates, the American public will have their eyes opened to the real political problems, and to the best candidate.

### Solid Choice

I have decided to vote for Ralph Nader this time around. And I fully intend to send his campaign a check to help them sway disenfranchised voters to vote again. Nader is the right person for the job. He has proven over and over that he will watch out for non-corporate and non-Republocrat needs. And, unlike the last presidential election, Nader plans to actively and persistently run for President, rather than being a passive, reluctant Green Party draftee.

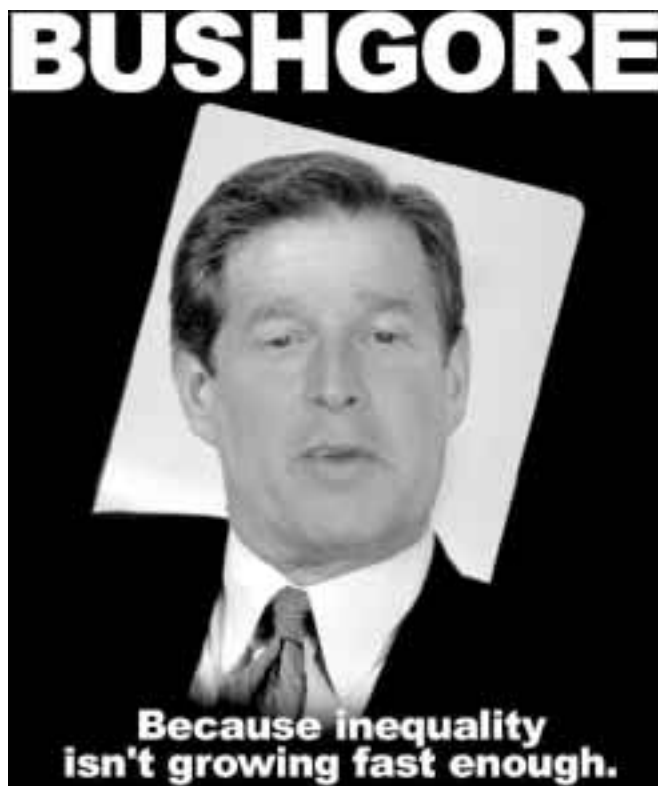
Ralph Nader is the only candidate who seems to understand the importance of RE. Combining that with his knowledge and wariness of corporate control makes him a natural to lead us toward a decentralized renewable energy future.

And even if voting for Nader gets Bush elected, I tend to agree with environmental leader David Brower of Earth Island Institute. He said, "It's better to have a president who you know is an enemy than to have a president who you think is a friend and is not."

### Campaign Humor

There seem to be more and more organizations around using humor to make political points. It is refreshing to see the humor of the situation. Leaving behind the doom and gloom can be empowering. Check out the Web site "Billionaires for Bush (or Gore)"—[www.billionairesforbushorgore.com](http://www.billionairesforbushorgore.com). This is a satirical organization set up by United for a Fair Economy that pokes fun at big money's corruption of our political process.

The Web site promoted two "Million Billionaire Marches" during the two Republocrat conventions last summer. These were spoofs of the Million Man & Million Mom marches that recently took place in D.C. Other humor on the site includes the Bush/Gore candidate comparison, in which both candidates look the same with check marks all the way down the comparison columns except in the categories "Republican" and "Democrat."



Al Bush...or George Gore?

There is also a spot called "66 Smart Billionaires," which lists corporations that have donated at least US\$50,000 to both Bush and Gore. That's right, both! When it comes right down to it, these companies do not care who gets elected, as long as they can get access when they need it.

This brings me to my favorite sad-but-true section of the Web site, which is called "Return on Investment." It states, "Attention Billionaires: If you're like most of us, you're always looking for higher returns on your investments. And while you may be familiar with stocks and bonds, currency speculation, IPOs, and all the rest, there's a new investment arena you really ought to be aware of: legislation."

It goes on to list several corporate campaign contributions and the resulting return on investment. The list starts with GlaxoWellcome, a huge international pharmaceutical firm that invested US\$1.2 million in campaign contributions. In return, they received a legislated 19 month patent extension on Zantac, one of their products. This resulted in a US\$1 billion payoff, or an 83,333 percent return on investment. Enough said.

More funny campaign stuff came across my desk in the form of a forwarded email. Filmmaker and comedian Michael Moore has decided to support the

Nader campaign for the same reasons I have. But he takes it a couple of steps further. In his email titled, "Bush and Gore Make Me Wanna Ralph," he says the Democrats should be sending campaign contributions to Nader.

Why? Because when all those former voters hit the polls to vote for Nader, they will also be voting for Congressional candidates. They will most likely vote for Democratic candidates, which could restore the Democratic majority. Then he says, "Or, better yet, let's try to elect enough Greens to Congress—a dozen or so—and they'll hold the deciding votes because neither the Democrats nor the Republicans will have the majority. It'll be a friggin' Knesset!"

The guy is too much. Check out his Web sites listed below, and sign up for his email newsletter, *The Awful Truth*. And don't forget to send your campaign contribution to Ralph Nader. He is also going to need a ton of volunteer help to get his message out. To find out how to help Nader in your state, go to [www.votenader.org/state/index.html](http://www.votenader.org/state/index.html), where you will find access info for Green Party organizations near you. If you don't have access to the Web, just give me a call, and I'll get that info for you.

#### Access

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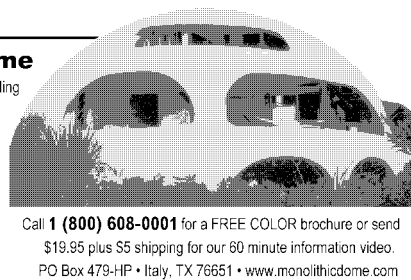
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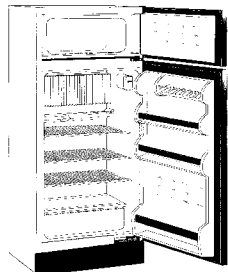


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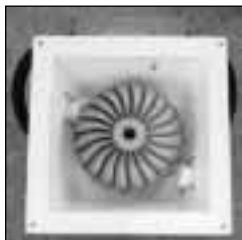
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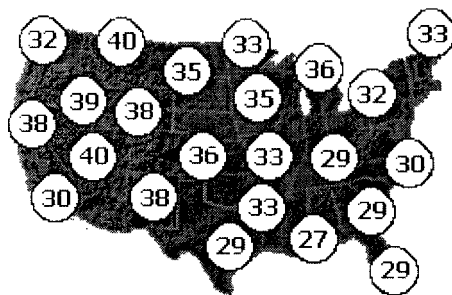


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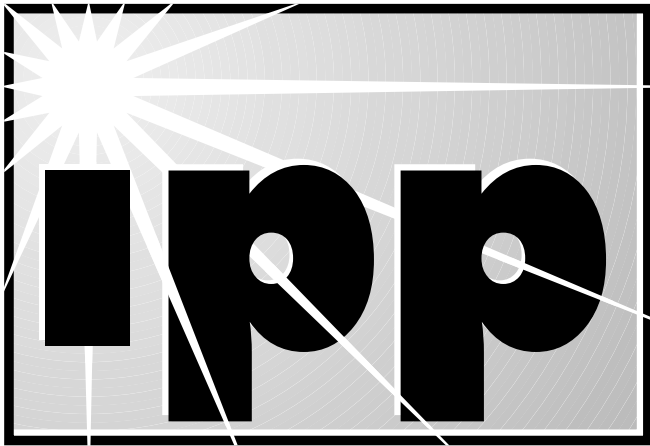
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## Y2K Again?

**A**re Y2K fears coming true? Well, not exactly, but lately we are getting Y2K in time-release doses. I'm referring to the eroding reliability of utility service in many parts of the country. Here on the west coast, power warnings go out every time we have a heat wave. Citizens are told to curtail electric consumption (sweating is good for you). In spite of voluntary reductions in consumption, utility customers are experiencing rolling blackouts.

I've read of similar events on the east coast too. Remember the promises we heard when the utility industry started going through restructuring in the late 1990s? Electric prices were supposed to go down! The exact opposite has occurred. In southern California, there are reports of electric bills doubling. One friend called to inform me that his electric bill had gone from \$11 to \$55.

Meanwhile, utility profits soar. A July 28, 2000 *San Diego Union-Tribune* headline read, "Sempra profits soar 34 percent in 2nd quarter." Sempra is the holding company that owns San Diego Gas and Electric. The situation is rudely ironic. Utilities scared voters into dumping California Proposition 9 with warnings of blackouts and high power bills. Prop 9 was a ballot

initiative that would have rolled back the utility bailout part of California's electric restructuring law. The proposition failed, but we are having outages and escalating power bills anyway.

In my last column, I referred to a *San Francisco Chronicle* story on distributed generation (DG). The story reported that Secretary of Energy Bill Richardson felt that "utilities are hindering the use of small generators such as fuel cells, small-gas turbines, and solar cells that allow consumers to produce their own electricity." Richardson also went a step further, stating that blackouts "could otherwise be avoided if the barriers to distributed generation were removed."

### Read the Full Story

The DOE study that prompted these statements is now available to the public (see *Access*). It is titled *Making Connections: Case Studies of Interconnection Barriers and their Impacts on Distributed Power Projects*. The study reiterates many of the points made in this column during the last few years regarding DG and utility practices that stifle DG interconnection. Twenty-six detailed case histories form the gist of the study. Of a total of sixty-five distributed generation projects surveyed, only seven experienced no problems.

The case histories stretch the imagination as to what the regulated and non-regulated utilities get away with. In five cases, utility obstruction resulted in projects being abandoned. In two other cases, the customers chose to disconnect completely from the utility, going off-grid rather than suffer further utility abuse. The authors also cite several occurrences of "pirate" or unauthorized interconnection.

### Some Possible Remedies

The study, in addition to providing documented case histories of utility abuse, presents a list of findings and a "Ten Point Action Plan." *Home Power* readers will be familiar with many of the findings and recommended actions. Point number 10 of the action plan bears special mention. The authors refer to "a right to interconnect."

This is probably the most fundamental element in a fully functional distributed generation system. But this right does not exist now. Every customer-generator must deal from scratch with their particular utility. When compared to our transportation and communications systems, the present system of utility fiefdoms—each with its own policy and rules—is archaic. This structure itself is a major barrier to DG.

### Computer Software for PV

I recently came across two software programs that may interest PV professionals and users. The first is called

WinVerter, and is published by RightHand Engineering. This software works in conjunction with the Trace communications adapter that is sold as an option for the SW and PS inverters. You must have the communication adapter to use this software.

The communications adapter allows SW and PS inverters to be remotely programmed with a laptop or other PC. WinVerter is a Windows-based program that replaces the DOS software shipped with the adapter. WinVerter provides a single screen on which all the inverter setup parameters are displayed simultaneously. I find it helpful to see all of the settings at once. To change a parameter or setting, you click on the appropriate box and enter the new value. When all the parameters have been entered, the changes are "written" to the inverter.

One very nice feature of WinVerter is that each setup can be named and saved as a file. This should make it much easier to recover from accidental loss of programming if the inverter's DC power source is turned off. This feature should be especially attractive to dealers who support numerous Trace SW and PS series inverters in the field. Randy Richmond, author of WinVerter, plans to introduce other products, including remote inverter programming over a phone-modem connection, and a logging program to record metered values over time. WinVerter is reasonably priced, looks good, and is easy to use.

The second program, Solar Design Studio V4, by Maui Solar Software, consists of a suite of programs written for the Windows operating system. The suite includes PV DesignPro for stand-alone, grid-connected, and water pumping systems. Also included on the CD is a program for active thermal system design, and an IV Curve Tracer (characterizes PV module performance), plus U.S. and global weather data.

The IV Curve Tracer represents the latest modeling of PV performance based on extensive field testing at Sandia Labs by David King and his colleagues. PV DesignPro uses the Sandia model as the heart of the design algorithm. The Sandia model not only incorporates the latest mathematics, but also includes significant adjustments based on empirical values derived from field testing. By using the IV Curve Tracer, you can quickly analyze module performance under a wide variety of conditions.

One of the most significant benefits of the program is that it more correctly characterizes cell temperature based on ambient air temperature, wind speed, and insolation (the amount of sunlight). The manufacturers' practice of basing a module's power output rating using a 20°C (68°F) cell temperature (room temperature)

verges on fraudulent. This remains the practice of module manufacturers, though systems are now beginning to be rated at normal operating cell temperature.

The difference between the methods is enormous. For example, using the IV Tracer program and entering an air temperature of 20°C results in a cell temperature of 50°C (122°F) with the module in full sun. At this cell temperature, the module produces only 80 percent of rated power. If one wished to obtain full manufacturer's rated power, the ambient air temperature would need to be -9°C (16°F).

### User Friendly

Using PV DesignPro is very easy. The program uses a graphical interface. System characterization is achieved by entering data in a sequence of windows. For example, click on an array icon and an array data window opens with entry boxes for module type, number of modules, etc. Then click on the next icon, opening the battery sizing window. Once all data entry is complete, the "calculate" icon is clicked, and after a few seconds the results are displayed. Since most of the displays are graphical, it's easy to understand the results.

You can review the fraction of energy delivered on a monthly or yearly basis, or view the results on a daily basis. Ease of use and elegant graphical displays make this program satisfying and fun to use. Most of the outputs can be printed, providing very high quality documentation and presentation support if required.

I have used pencil and paper for years to size systems, and have developed a few empirical fudge factors that seem to work. As a check on my methods and the program, I ran the numbers from a few of my own successful systems through the program. The results from the program generally represented the real world systems and how they performed.

Besides being a very good design tool for the professional, DesignPro is also a great learning tool. "What if" scenarios can be set up and quickly run, providing invaluable lessons. For more information, contact Michael Pelosi at Maui Solar Software. Let him know you read about the program in *Home Power*. One caution: DesignPro is a very computation-intensive program. It makes hourly computations over a one year period—that's over 8,700 complex computations. A fast, capable computer is required.

### Photovoltaic Distributed Power Coalition

The California Public Utilities Commission is holding hearings (Order Instituting Rulemaking, OIR 99-10-025) about regulation changes for distributed generation.



The Photovoltaic Distributed Power Coalition (IPP, CalSEIA, Powerlight, AstroPower, Green Mountain Energy, and BP Solarex) represents the interests of the PV industry, and has presented testimony to the commission.

Phase I and Phase II testimony is now complete. The purpose of the testimony is to have the commission adopt regulatory policy favorable to the PV industry, PV system integrators, and PV system users. I've stated the goals of the coalition here in general terms in previous columns. Now that the testimony is public record, it is possible to detail the specific recommendations. The following five points are excerpted from the Phase II testimony of Tom Starrs on behalf of the coalition. Starrs is an RE advocate and attorney based in Washington state who helped formulate many of the net metering laws being implemented across the country.

- "Eliminate standby charges for on-site solar electric facilities up to 1 MW peak generating capacity." Customer-generators would not be charged any additional fees. No net metering would be required by utilities for excess capacity, but customer-generators might negotiate a power sales contract with an energy service provider.
- "Preserve existing usage-based rates that allow customers to use electricity generated on site to supply their own loads and therefore to offset bundled retail prices, including distribution charges and other restructuring-related charges, unless and until there is concrete evidence of net economic losses significantly affecting utility profitability or utility rates." Utilities are proposing to shift from the current usage-based rates to fixed rates. Fixed rates will reduce the value and economic incentives for on-site solar.
- "Consider the adoption of performance-based ratemaking approaches that make the utility indifferent to the amount of energy "throughput" on its system, such as revenue-cap regulation." This eliminates the utilities' incentive to discourage customer self-generation.
- "Consider the adoption of financial incentives, in the form of geographically de-averaged buyback rates, to reward the installation and operation of on-site solar applications in designated areas with high distribution costs." The installation of on-site solar generation in distribution impacted areas may eliminate the need for substation upgrades or distribution system expansion by the utility. Reward these "distribution benefits."
- "Develop appropriate schedules for distribution wheeling that fairly balance the interests of utilities

and developers of on-site solar applications." Rates to wheel solar-generated power to other customers should reflect the incremental or actual cost to the utility when transporting excess solar energy from the generation site to a second customer's site within the same distribution system. (Wheeling is the transport of independently generated electricity to customers using utility owned wires.)

Readers interested in an electronic copy of the full testimony should contact IPP. Thanks to those who have supported this very important project. And, of course, there continues to be a great need for financial support. Checks should be made payable to IPP.

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### \$\$\$\$\$

Financing PV systems has been a problem for years. Based on my experience to date, most residential PV customers still pay cash. There is some good news, though. Thanks to the hard work and persistence of Keith Rutledge at the Renewable Energy Development Institute (REDI), one company in northern California has been making solar loans now for over a year.

Terry Phenicie heads Valley Financial in Ukiah, California. Last year, one of my customers obtained financing through the company for an off-grid straw bale home with PV. I called Terry to get more information. Valley has set up a very streamlined process for qualifying loan applications. One option is a single page application, available to PV contractors.

When meeting with a serious customer who needs financing, the application can be made on the spot. Valley Financial promises a 48 hour turnaround. A second option is to make the loan application online at Valley's Web site. Valley Financial writes loans for projects throughout the country, not just in California.

### Leaders & Followers

During the last ten years, I have repeatedly gone to local banks and lenders searching for financing. The loan officers were generally attentive and, in principle, supportive. However they always took the position that because there were no off-grid PV homes already financed in their local area, they would not risk making such a loan.

I've come to the conclusion that the financial community is made up of mostly followers. Valley Financial stands out, and should be rewarded for their leadership in PV financing. I suspect that by this time next year, many of the followers will wake up and see the opportunity. I prefer to work with companies like Valley Financial—companies with enough vision to take a risk and not be bound to the herd.

## Access

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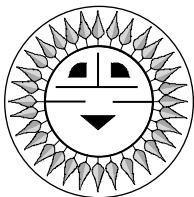
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# PV Modules, Conductors, & the Code



John Wiles

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**P**hotovoltaic (PV) modules produce electrical energy when exposed to light and connected to a load.

Determining the necessary conductors to move this energy from the module to the load is frequently a confusing task.

I'll start by discussing the rating information listed on the back of the module, and how those ratings are determined. Next I'll cover the varying environmental conditions, and the requirements of the National Electrical Code (*NEC*). All of these factors will be used to establish the ampacity requirements of PV conductors.

## Laboratory Ratings

PV modules are rated by the manufacturers in laboratories or on the assembly line under a set of test conditions called "standard test conditions" (STC). These conditions are: an irradiance of 1,000 watts per square meter ( $\text{W/m}^2$ ), a PV cell temperature of  $25^\circ\text{C}$  ( $77^\circ\text{F}$ ), and some other less important (for our purposes) factors.

The actual measurements are made using a solar simulator that can produce a light of the correct intensity and spectrum. The room or test chamber is maintained at  $25^\circ\text{C}$  ( $77^\circ\text{F}$ ) to keep the module cells at this temperature. The duration of the light exposure is so short that there is no appreciable heating of the cells in the module. While the light is on, a specialized tester called an IV curve tester measures the open-circuit voltage, the short-circuit current, and the peak-power-point operating voltage and current. The tester can also record data for the complete current vs. voltage curve (IV curve) for the module.

Some manufacturers label each module with the test results of that particular module, while others print the average values for that model. Each manufacturer guarantees the power output of the modules in slightly different ways. In addition to the numbers mentioned

above, the module label will also contain the maximum power output rating (at STC), the maximum open-circuit voltage (usually 600 volts or less), the maximum series fuse (to protect the module), and the National Fire Protection Association (NFPA) fire rating. The fire rating is used with local building codes when the PV module is to be mounted on a roof.

## Field Operating Conditions

When PV modules are installed, they are no longer in benign, indoor laboratory conditions. They are exposed to long-duration sunlight, ambient air temperatures, winds, and other environmental conditions.

Ambient air temperatures in the United States may reach  $50^\circ\text{C}$  ( $122^\circ\text{F}$ ) in some locations, and can be lower than  $-40^\circ\text{C}$  ( $-40^\circ\text{F}$ ) in other locations. The modules may be mounted where they are not exposed to cooling breezes, causing them to operate at higher temperatures. In other situations, the modules may be on open racks exposed to high steady winds, which can keep their operating temperatures at or very near ambient temperatures.

When sunlight falls on a module, the module is heated. The temperature rise of the module cells and the module junction box depends on the intensity of the sunlight and the amount of cooling the module experiences, either through natural convection and radiation or from cooling breezes. Modules may be exposed to sunlight that can range in intensity from  $0 \text{ W/m}^2$  (night) to values as high as  $1,500 \text{ W/m}^2$  under cloud-enhancement conditions. A sunlight intensity of  $1,000 \text{ W/m}^2$  (the average over the surface of the earth at sea level) just happens to be the value used for rating modules. In many locations throughout the USA, the sunlight peaks at  $1,100$ – $1,200 \text{ W/m}^2$  for several hours each day.

With high winds, modules may operate in bright sunlight at the local ambient air temperature, which can be very cold in some locations. In other installations, high ambient air temperatures and no cooling winds can lead to very high operating temperatures for the modules.

Module manufacturers sometimes publish a "normal operating cell temperature" (NOCT) for their modules, which is measured with an irradiance of  $850$  or  $1,000 \text{ W/m}^2$ , an ambient temperature of  $20^\circ\text{C}$  ( $68^\circ\text{F}$ ), and a windspeed of  $1 \text{ m/s}$  ( $2.24 \text{ mph}$ ). The NOCT for crystalline silicon modules is in the  $44$ – $48^\circ\text{C}$  ( $111$ – $118^\circ\text{F}$ ) range. In the Southwest, with light or no wind, we typically see modules operating  $25$ – $35^\circ\text{C}$  ( $77$ – $95^\circ\text{F}$ ) above ambient air temperatures with module cell and junction box temperatures as high as  $75^\circ\text{C}$  ( $167^\circ\text{F}$ )—considerably higher than the NOCT.

Crystalline PV modules lose power at about 0.5 percent per degree Celsius as their temperatures increase above the STC rating temperature of 25°C (77°F). With an NOCT of 47°C (117°F), the module is operating 22°C (72°F) above 25°C, and has lost 11 percent of its rated power. On hot summer days in many parts of the country, PV modules are frequently operating at 65°C (149°F), and have lost 20 percent of their rated power due to heating. The lost power is largely due to reductions in the peak-power operating voltage point of the module as temperatures increase. Further power losses may be experienced if the battery operating voltage pulls the module operating point off the already lowered peak-power point.

### Module Operating Voltages

When a PV module operates at temperatures below 25°C (77°F) in low ambient air temperatures and/or high winds, the open-circuit voltage increases above the rated open-circuit voltage measured at 25°C. This varies slightly from manufacturer to manufacturer, and from crystalline silicon modules to thin-film technologies. The actual open-circuit voltage is the voltage that stresses the insulation on conductors and the insulation in circuit breakers, fuses, and switchgear. It also determines whether fuses and circuit breakers will function near the limits of their voltage ratings.

Since the module manufacturer and many installers do not know how low the temperatures may go in a particular installation, the instructions supplied with the module (as required by UL Standard 1703) currently state that the rated open-circuit voltage (Voc) of the module must be multiplied by 125 percent prior to determining the system operating voltage.

The *NEC* then requires that the system voltage be determined by multiplying the number of modules connected in series by this new open-circuit voltage (I call it the “design” voltage). This system voltage is then used to determine the voltage rating of conductors, switchgear, circuit breakers, and fuses. This ensures that under the worst case, cold temperature conditions, the PV array will not generate voltages that are in excess of the ratings of the components in the system.

A table was added to the 1999 *NEC* to acknowledge the fact that historical weather data may be used to determine the lowest temperature at many locations. A Web source for this data is referenced below. Instead of a straight multiplier of 125 percent, *NEC* Table 690-7 allows a variable, temperature-dependent multiplication factor to be used when the lowest temperature is above -40°C (-40°F).

These voltage correction factors are important in both high-voltage and low-voltage PV systems. In high-

### Voc Correction Factors for Temperature\*

Lowest Ambient Temperature		Multiply Voc by:
Centigrade	Fahrenheit	
25 to 10°	77 to 50°	1.06
9 to 0°	49 to 32°	1.10
-1 to -10°	31 to 14°	1.13
-11 to -20°	13 to -4°	1.17
-21 to -40°	-5 to -40°	1.25

\* From NEC Table 690-7

voltage systems, the older 125 percent (1.25) multiplication factor limited the rated open-circuit voltage to 480 volts DC. When multiplied by the 1.25 factor, this gave a system voltage of 600 volts—a significant limiting voltage in the code and on most modules. This represents about 22 PV modules (Voc of 21.8 volts) in series. Some high-voltage inverters really need 24 modules in series to function properly in high-temperature environments without added equipment. With a multiplication factor of say 1.10, 24 modules with a Voc of 22 volts could be connected in series and not exceed the 600 volt limit.

In low-voltage systems, many installers want to use the inexpensive Square D QO circuit breakers and load centers that are rated at 48 volts DC. In a nominal 24 volt system, using the 1.25 multiplier, the system voltage is about 55 volts ( $2 \times 22 \times 1.25 = 55$ ), which exceeds the 48 volt rating of the circuit breaker. However, if it can be determined that ambient temperatures do not go below 0°C (32°F), Square D QO circuit breakers may be appropriate, since the system voltage would be 48 volts ( $2 \times 22 \times 1.10 = 48.4$ ).

As the code mentions in Section 690-7, if you are using other than silicon-type PV modules (such as some of the newest thin-film modules), the manufacturer should be consulted for information on the maximum expected open-circuit voltages at the lowest temperatures in your location.

Eventually, the Underwriters Laboratories (UL) Standard 1703 will be revised to clarify the calculation of maximum voltage, and Section 690-7 of the *NEC* will establish and articulate the requirement. In the meantime, a good rule would be to ignore the 125 percent requirement in the instructions supplied with modules (based on UL 1703), and just apply Section 690 and Table 690 in the 1999 *NEC*. If the minimum temperature is unknown, a 125 percent multiplying factor should be used as shown in Table 690-7 for temperatures below -40°F (-40°C).

### Module Operating Currents

Module currents are nearly a linear function of the

intensity of the sunlight. The current does increase very slightly as temperature increases. But the voltage drop as temperature increases is much greater, and hence the module power decreases as temperature increases. The module is rated at STC with a short-circuit current and a peak-power current.

Since we want the PV modules to deliver power under all sunlight conditions, the current the wiring must handle must be carefully considered. In normal daily operation, the sunlight may be as high as 1,100–1,200 W/m<sup>2</sup> for several hours around solar noon. This is up to 120 percent of the 1,000 W/m<sup>2</sup> used to rate the modules at STC.

In some instances, clouds may gather so that reflections from the vertical cloud surfaces concentrate the sunlight on the module with irradiance values up to 1,500 W/m<sup>2</sup>. This results in correspondingly high values of power and output. These cloud-enhancement conditions are not static, and rarely last more than a few minutes. So we need not worry about steady-state currents at these levels.

Another factor to consider is that some shunt-type PV charge controllers short circuit the PV module to control the battery charging process. That means that we want the module conductors and overcurrent devices to be able to handle the rated short-circuit current, and any normal currents that are above that value on a regular basis. Based on 30+ years of experience with terrestrial PV systems, the PV industry selected a factor of 125 percent for increasing the rated (at STC) module short-circuit current to determine a “design” current that would account for the higher current conditions. This design current is used to size the conductors and to determine the rating of overcurrent devices.

With a conductor ampacity of 125 percent of the STC-rated short-circuit current, the conductors are assured of being able to handle the normal and expected daily currents without overheating. Fuses and circuit breakers sized at this 125 percent value will not trip in normal operation. These overcurrent devices will, however, protect the module and array conductors from high fault currents originating from the batteries, parallel connected PV modules, or grid backfeed through utility-interactive inverters.

Of course, there may be some very unusual conditions where the ambient temperatures are very cold, the winds are high, there is reflective snow or water at just the right angle, or the clouds form a lens. In these very rare conditions, the overcurrent devices may trip. But the *NEC* and *UL* do not require us to overdesign for these conditions, just for those conditions that can be expected periodically in most systems.

We have now determined the normal, expected daily current output of a PV module. This multiplication of 125 percent will be found in both the *UL*-required instructions for the modules and in the 1999 *NEC* in Section 690-8,9. Again, *UL* Standard 1703 will be modified to clarify the current multiplier in the module instructions, and the 125 percent requirement for current correction will appear only in the code. Installers should not use both of these particular 125 percent factors, only one.

Note that the *NEC* has requirements established not only in Article 690, but in Article 240 and elsewhere throughout the code that prohibit overcurrent devices and conductors from being operated at more than 80 percent of rating. For example, a 15 amp AC branch circuit protected by a 15 amp circuit breaker may be loaded to no more than 12 amps (80 percent of 15) on a continuous basis. If we had a vacuum cleaner drawing 12 amps, it would have to be connected to a circuit rated for at least 15 amps (125% of 12 is 15). This 80 percent safety factor requirement is related to the long-term durability of components in tight, hot environments like load centers.

### Conductor Ampacity Requirements

A second 125 percent multiplier (the reciprocal of the *NEC* 80 percent safety factor of  $1/1.25 = 0.80$ ) is used to determine the design current for the module. In the module and array wiring for PV systems, we must use both of the 125 percent factors (increased sunlight and 80 percent limit) to determine the ampacity of the conductors and the rating of the overcurrent devices. The combination of the two factors of 125 percent yields an overall multiplier of 156 percent ( $1.25 \times 1.25 = 1.56$ ).

The array wiring and overcurrent device calculations are based on the number of modules or strings of modules that are connected in parallel. A few circuit breakers are listed for operation at 100 percent of rating (consequently, one of the 125 percent factors is not required for these breakers). But these devices are usually only found in factory-assembled and listed components.

### Summary

We now have a starting point for determining the ratings for PV array conductors and overcurrent devices. The voltage rating for conductors and overcurrent devices is based on a temperature-dependent factor from Table 690-7 of the *NEC*. This is used to multiply the STC-rated open-circuit voltage marked on the back of the crystalline silicon module. Thin-film module manufacturers provide this information in the module instructions. This module design voltage

is then multiplied by the number of modules that are connected in series to determine the system voltage. All conductors and overcurrent devices should have a voltage rating at least this high.

The module rated short-circuit current (at STC) gives us a starting point for determining the required ampacity for conductors and overcurrent device ratings. First, we multiply the rated short-circuit current by 125 percent to allow for the normal expected daily variations in the current produced by the modules. Then, to meet the *NEC* requirements for not operating conductors or overcurrent devices at more than 80 percent of rating, the first product of 125 percent times the short-circuit current is again multiplied by a second 125 percent. The product of the two ( $125\% \times 125\%$ ) is 156 percent. This design current is the number used for overcurrent device ratings and the ampacity of conductors.

In the next *Code Corner*, I will present some examples of module and array wiring and overcurrent protection.

#### Questions or Comments?

If you have questions about the *NEC* or the implementation of PV systems following the requirements of the *NEC*, feel free to call, fax, email, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV

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# Home & Heart



Kathleen Jarschke-Schultze

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**N**ot everyone who uses renewable energy lives in the boondocks. Every year, more people opt for grid-intertie systems. This column is not for them. It is for the families that are far from the nearest town, down the dirt road a ways.

## Country Living

The least expensive land is usually beyond the grid. Solitude and space are out there. When your closest neighbor is a quarter mile or more away, you usually become good friends. If you can't see another house from your own, the view is always beautiful. The problem comes when the local authorities can't figure out why the heck anyone would go live way out there. Their usual conclusion is that if you aren't retired, you must be doing something illegal.

## Over My Head

When I first came to live with Bob-O in the mountains, I had my first taste of *law vs. boondocker* discrimination. Every autumn, the local sheriff's office, in conjunction with the U.S. Forest Service, would fly the CAMP (Campaign Against Marijuana Planting) helicopter over the mountains and drainages looking for illegal plantations. In theory, that's okay. What is not okay is when that authority is overstepped, and the helicopter flies directly over dwellings at less than 500 feet, becoming illegal itself.

When this first happened to me, I really didn't understand why the helicopter seemed so interested in our cabin. I told my friend Sarah about it and she explained who they were and their excuse for being there. She also advised me, "Don't moon them, they'll just come back for a closer look."

## Night Flight

Another friend was wakened in the wee hours of the morning by a cabin-shaking "thwock, thwock, thwock." She immediately recognized it as a helicopter. However, having one of the few meadows of flat land in

the mountains, she thought it must be a medical emergency helicopter looking for a safe landing area.

She threw on a minimum of clothes and ran outside to turn on her truck headlights to help the pilot see to land. She figured that if the helicopter was flying at night, it must be a catastrophic emergency. To her immense relief followed by righteous rage, it turned out to be the C.A.M.P. helicopter hovering so close to her cabin that the windows rattled.

That night the helicopter buzzed quite a few local homes. Complaints were lodged. When the matter was investigated by the authorities, they admitted that the helicopter had flown that night. But they could find no record or log of who the crew was or who had authorized the night flight. The investigation of the whole episode was dropped.

## Got Law?

Several years later, the helicopter used by CAMP was painted flat black, with no markings or identifying numbers on it. It came up one drainage and circled a home below the 500 foot legal limit. It then proceeded up the canyon to the next home and circled there, again below the limit. The first neighbor watched it circle the second home after it left his. The second homeowner called the local gendarmes while the helicopter circled.

He was first told that it wasn't their helicopter. He then got angry enough to make a big mistake. He verbally threatened the helicopter to the officer on the phone. After about ten minutes, the helicopter quit circling that home and could be seen continuing up the canyon circling the other homes there.

Six months later, sheriff's deputies arrived at the second home in bulletproof vests to handcuff and arrest the homeowner. The charge was "terrorist threats." The bail was \$5,000. This guy was such a threat that it was half a year after the offense that the officials got around to arresting him. All that time there was a warrant out for his arrest, but he had no knowledge of it. He could have been arrested at any time, anywhere, without warning. They didn't even know what he did for a living. Some investigation. Some threat.

So began a series of appearances in court. First he had to appear to say he would hire his own lawyer. Then he had to appear, to hire that lawyer. In his next appearance, the D.A. had the charge lowered to "annoying phone call" (because "terrorist threats" would be very difficult to prove at this late date). He also had witnesses willing to testify on his behalf that the helicopter was too low. After four appearances in court, the defendant asked for his bail money back. He had lived in the county most of his life, worked there, and owned his own home.

The judge would return his bail money only if he opened his person, his vehicle, and his home to search at any time without probable cause. This was unacceptable to the defendant. The judge disregarded the fact that the whole incident took place because the defendant felt the helicopter crew overstepped their authority and violated his legal rights in the first place.

The upshot was that the defendant was offered a "court diversion." After a year of not having any run-ins with the law (he had never had any before), the homeowner was granted an "unconditional dismissal" of the charges. After the court diversion was offered to and accepted by the defendant, the \$5,000 was returned to his wife, who had bailed him out.

When asked about the the incident, the officer in the helicopter denied flying over the house, and said he flew off to the side of the house over a "suspected marijuana site." This turned out to be the water run-off of a buried spring box, out in a meadow with no trees or brush around it. The runoff had caused the plant growth around the drain pipe to be green on an otherwise dry, yellow hillside.

#### What You Can Do

If this happens to you, grab a camera and walk far enough from your house to be able to get the helicopter and the house in the same picture. Also take pictures of just the helicopter. Zoom in with your camera to identify the helicopter and its occupants.

Record the date, time, and length of the incident. Do not call the authorities. Call your neighbors instead and ask them to take pictures and watch the progress of the helicopter, if possible. Will this get it stopped? No, but it's best to be prepared if you decide to pursue the matter.

You could also contact the Civil Liberties Monitoring Project. This California organization keeps a record of helicopter abuses under the guise of law enforcement. While they focus on a three-county area in our neighborhood, they are very aware of the issues and may be able to refer you to other organizations.

This could just be a western phenomenon. I don't know. Most remote home dwellers in the West have a helicopter story. The main thing is to remain calm and clear headed. Get pictorial evidence of the incident, date, times, etc. Seek legal advice if you are going to pursue it. As a friend once told Bob-O, "Don't ever expect justice from the American justice system; the best you can hope for is an even-handed application of law." And remember, don't moon them.

#### Access

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Reviewed by Michael Welch

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**R**eNew, the fantastic quarterly magazine from Australia, has a lot in common with *Home Power*. It covers many of the same subject areas, with a “down under” bent, and with a little more emphasis on the non-energy aspects of sustainable living. The new CD of their back issues gets a solid thumbs up from me.

The early incarnation of *ReNew* was called *Soft Technology*, and was first published in 1980. The CD-ROM contains the complete first forty issues of the magazine in Adobe Acrobat format. There is an incredible amount of excellent information here. I've spent many hours perusing the CD, and still have barely scratched the surface. The CD and magazine are produced by Alternative Technology Association (ATA), a non-profit community organization that has used and promoted sustainable technologies since 1975. They've got their stuff together.

For an example of the caliber and level of technical information included, here is the CD's index listing for “Micro Hydro”:

A homemade waterwheel . . . . . 13-7  
A low technology reaction water turbine . . . . . 24-6

Cross-flow turbine design . . . . . 35-33, 37-16  
Flood damage to small water turbines . . . . . 32/33-48  
John Hutchinson's low-head community hydro 32/33-15  
New developments in water turbines . . . . . 25-26  
Pedal's Pelton wheel . . . . . 22-34  
Peter Pedal's personal power production . . . . 32/33-46  
Private hydro co-generation in NSW . . . . . 24-5  
RPC Pelton wheel (Products) . . . . . 32/33-10  
Small propeller turbines . . . . . 32/33-40  
Soma Watter micro-hydro turbine (Products) . . . . 36-6  
The Segner turbine . . . . . 31-11  
The Tyson turbine-power from river flow . . . . . 35-11  
Water power (Pelton wheel) . . . . . 9-16  
Water power with an axial flow turbine . . . . . 26-6  
Low technology waterwheel . . . . . 21-6

As you can see, the index is very tantalizing. I can assure you that the rest of the index entries and articles are just as good. The numbers after each index entry refer to the issue and page numbers of the article.

The CD is pretty much limited in scope to the back issues of the magazine—no extra lectures, video clips, data, etc. There is some background info on ATA and its programs, along with membership info, *ReNew* subscription info, contributors' guidelines, and advertising rates.

There is one drawback to the CD that deserves only minor mention (hey, nobody's perfect). There is no cross-document search capability. This is because the early years of the magazine were not available digitally, and therefore were scanned instead of being distilled from the original electronic page layouts. But the index appears complete and well thought out. The CD contains the freeware Acrobat Reader to view all the magazines on the disk.

I highly recommend this great resource. ATA promises a second edition late this year or early next year that will cover issue 41 and onwards. I can hardly wait.

#### Access

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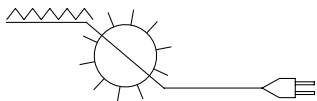
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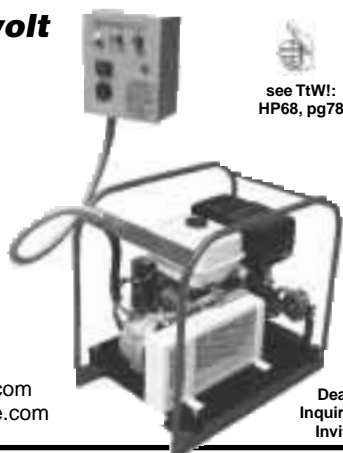
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# HAPPENINGS

## INTERNATIONAL

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www.sungravity.com

## CANADA

Oct. 15–18 '00. International EV Symposium: exhibition & drive. Race an EV on a Formula One track. EVS-17  
650-365-2802 • Fax: 650-365-2687  
ElectricEvent17@aol.com

Oct. 21–24, '00. Halifax, Nova Scotia. Rise and Shine 2000, Canada's 26th National Solar Energy Conference. Keith Robertson • 902-422-1557  
www.chebucto.ns.ca/Technology/RS2000

Alberta Sustainable House: open house 3rd & 4th Saturdays, 1–4 PM. Cold-climate features/products regarding health, environment, conservation, RE, recycling, low energy, self-sufficiency, appropriate technology, autonomous & sustainable housing. Free. 9211 Scurfield Dr. NW, Calgary, AB T3L 1V9 Canada • 403-239-1882  
Fax: 403-547-2671 • jdo@ucalgary.ca  
www.ucalgary.ca/~jdo

The Institute for Bioregional Studies demonstrates & teaches ecologically-oriented, scientific, social, & technological achievements. IBS, 393 University Ave., Charlottetown, PEI C1A 4N4 Canada • 902-892-9578

Vancouver Electric Vehicle Association. Call for meeting info. PO Box 3456, 349 West Georgia, Vancouver, BC V6B 3Y4 Canada • 604-878-9500  
info@veva.bc.ca • www.veva.bc.ca

## CHINA

Nov. 23–26, '00. Beijing. Intl. Development & RE Conference. Info: CERE 2000 Secretariat, Yong ZHANG, No. 1 Sandaokie, Jianguomenwai, Beijing 100022, P.R. China  
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Fax: 86-10-65158442  
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## NICARAGUA

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www.kih.net/aspi

American Wind Energy Association. Info about U.S. wind industry, membership, small turbine use, & more.  
www.awea.org

State financial & regulatory incentives for RE reports. North Carolina Solar Center, Box 7401 NCSU, Raleigh, NC 27695 • 919-515-3480 • Fax: 919-515-5778 • www.ncsc.ncsu.edu/dsire.htm

Energy Efficiency & Renewable Energy Clearinghouse (EREC): Insulation Basics (FS142), New Earth-Sheltered Houses (FS120), PV: Basic Design Principles & Components (FS231), Cooling Your Home Naturally (FS186), Automatic & Programmable Thermostats (FS215), & Small Wind Energy Systems for the Homeowner (FS135). EREC, PO Box 3048, Merrifield, VA 22116 • 800-363-3732  
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energyinfo@delphi.com  
www.eren.doe.gov

Energy Efficiency & Renewable Energy Network (EREN): links to gov. & private internet sites & offers "Ask an Energy Expert" online questions to specialists. 800-363-3732 • www.eren.doe.gov

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national & state policies. Global Environmental Options & CREST  
www.green-power.com

National Wind Technology Center. Assisting wind turbine designers & manufacturers with development & fine tuning. Golden, CO • 303-384-6900  
Fax: 303-384-6901

Tesla Engine Builders Association: info & networking. Send SASE to TEBA, 5464 N Port Washington Rd. #293, Milwaukee, WI 53217  
teba@execpc.com  
www.execpc.com/~teba

Sandia's Stand-Alone Photovoltaic Systems Web site: recommended design practices, PV safety, balance-of-system technical briefs, & battery & inverter testing. www.sandia.gov/pv

Solar Energy & Systems. Fundamentals of Small RE: Internet college course. Weekly assignments reviewing texts, videos, WWW pages, & email Q&A. Mojave Community College  
800-678-3992  
lizcaw@et.mohave.cc.az.us  
www.solarnmc.mohave.cc.az.us

Federal Trade Commission (free pamphlets): Buying An Energy-Smart Appliance, Energy Guide to Major Home Appliances, & Energy Guide to Home Heating & Cooling. Energy Guide, FTC, Rm 130, 6th St. & Pennsylvania Ave. NW, Washington, DC 20580 • 202-326-2222  
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## ALABAMA

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## ARIZONA

Glendale & Scottsdale, AZ. Living with the Sun: lecture series by AZ Solar Energy Assoc. How to save money & the environment. History & current overview of concepts, design, applications, & technologies on solar heating/cooling, architecture,

landscaping, PV, & cooking. 7–9 PM, first Wed. of every month at Glendale Foothills Branch Library & third Tuesday of every month at Scottsdale Redevelopment & Urban Design Studio. Jim Miller • 480-592-5416

Tax credits for solar in AZ. A technician certified by the AZ Department of Commerce must be on the job site. ARI SEIA 602-258-3422

## ARKANSAS

Mt. Ida, AR. Sun Life Construction by Design: Seminars 3rd Sunday of each month on our passive solar earth-sheltered project. Hands-on seminars incl. ferro-cement, building dwellings for minimal materials expense. US\$40 per day (includes construction manual). Loren Impson, 71 Holistic Hollow, Mt. Ida, AR 71957 • 870-867-4777  
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## CALIFORNIA

Arcata, CA. Campus Center for Appropriate Technology, Humboldt State University. Ongoing workshops & presentations on alternative, renewable, & sustainable living. CCAT, HSU, Arcata, CA 95521 • 707-826-3551  
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Energy Efficiency Building Standards for CA. CA Energy Commission 800-772-3300  
www.energy.ca.gov/title24

Hopland, CA. Workshops through Oct. on RE, straw bale, ecological design, & sustainable living. Institute for Solar Living, PO Box 836, Hopland, CA 95449 • 707-744-2017 • isl@rgisl.org  
www.solarliving.org

## COLORADO

Carbondale, CO. Solar Energy International: hands-on workshops. 1 & 2 week sessions. PV design & installation, advanced PV, wind power, microhydro, solar cooking, environmental building technologies, solar home design, & straw bale construction. Experienced instructors & industry reps. For owner-builders, industry technicians, business owners, career seekers, & international development workers. US\$500/week. SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855  
Fax: 970-963-8866  
sei@solarenergy.org  
www.solarenergy.org

## ILLINOIS

Oct. 14, '00. Macomb, IL. Alternative Resources For A Healthy Environment Expo 2000. Western Illinois University campus. Soy, cotton, kenaf, amaranth, & hemp products. Solar cars, solar ovens, bluegrass/folk music. 9–4 PM, US\$2. Sponsored by Save Our Land & Environment, 309-837-3150  
Fax: 309-833-1176  
http://homepages.go.com/~earthprotect

## IOWA

Prarie Woods & Cedar Rapids, IA. Iowa Renewable Energy Association meets 2nd Sat. every month at 9 AM. All welcome. Call for schedule changes. IRENEW, PO Box 466, North Liberty, IA 52317 • 319-875-8772  
irenew@irenew.org • www.irenew.org

## KENTUCKY

Oct. 21, '00. Mt. Vernon, KY. Solar Tour Day: Appalachia—Science in the Public Interest. Solar cookers, dryers, fans, space heating, water heating, automobile, greenhouses, PV systems, & more. ASPI, 50 Lair St., Mt. Vernon, KY 40456 • 606-256-0077  
aspi@kih.net • www.kih.net/aspi

Livingston, KY. Appalachia—Science in the Public Interest. Projects & demos in gardening, solar, sustainable forestry, more. ASPI, Rt 5 Box 423, Livingston, KY 40445 • Phone/Fax: 606-453-2105  
aspi@kih.net • www.kih.net/aspi

## MASSACHUSETTS

Greenfield Energy Park needs help preserving historic past, using today's energy & ideas, creating a sustainable future. Greenfield Energy Park, NESEA, 50 Miles St., Greenfield, MA 01301 413-774-6051 • Fax: 413-774-6053

## MICHIGAN

Tillers International, classes in draft animal power, small farming, blacksmithing, woodworking. 5239 S 24th St., Kalamazoo, MI 49002 616-344-3233 • Fax: 616-344-3238  
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www.wmich.edu/tillers

## MONTANA

Whitehall, MT. Sage Mountain Center: seminars & workshops, one day, inexpensive sustainable home building, straw bale const., log furniture, cordwood const., PV, more. SMC, 79 Sage Mountain Trail, Whitehall, MT 59759 • Phone/Fax: 406-494-9875  
cborton@sagemountain.org

## NEW MEXICO

Moriarty, NM. workshops on RE, energy conservation, sustainable living, & energy independence. Profit From The Sun • 505-281-1300 days  
505-832-1575 eves & weekends  
proffit@flash.net  
www.proffitfromthesun.com

## NEW YORK

Oct. 15–19, '00. Bioenergy 2000—Moving Technology into the Marketplace: the 9th Biennial Bioenergy Conference. NRBF, 202-624-8464  
nrpb@sso.org

## NORTH CAROLINA

Saxapahaw, NC. How to Get Your Solar-Powered Home: seminars 1st Sat. each month. Solar Village Institute, PO Box 14, Saxapahaw, NC 27340 336-376-9530 • Fax: 336-376-1809  
solarvil@netpath.net

## OHIO

Perrysville, OH. RE Classes: 2nd Sat. of each month, 10–2 PM. Tech info, system design, NEC compliance, efficient appliances, hands-on straw bale post & beam building. US\$70, or US\$90 w/spouse, in advance. Solar Creations, 2189 SR 511 S., Perrysville, OH 44864 • 419-368-4252  
www.bright.net/~solarcre

## OREGON

John Day, OR. Oct. 21, '00. Spend an autumn morning finding out how to have warm windows for the whole winter, & all your winters! Help to install Window Quilts in the EORenew office. Ray Pokorny of Solar Interior Design will put up one quilt as a demo. Students will make & install the second quilt as hands-on training. 9 AM–noon. Tuition \$25. SolWest/EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633  
solwest@highdesertnet.com

John Day, OR. EORenew Workshops. October 21, '00: Window Quilt Construction & Installation workshop (\$25). Spring '01 (date TBD): Simple Solar Water Heater Installation (hands-on) by Anthony & Victoria Stoppiello. Mid-June '01: Hands-on installation, 1kW wind genny & 100-foot tilt-up tower, in a hybrid system at Morning Hill Forest Farm; followed by 1-day workshop, "Monitoring & Metering of RE Systems with Data logging." Last week of July '01: SolWest pre-fair workshop, hands-on microhydro installation on hybrid system. EORenew, PO Box 485,



## Happenings

Canyon City, OR 97820 • 541-575-3633  
info@solwest.org • www.solwest.org

### TENNESSEE

Summertown, TN. Kids to the Country: a nature study program for at-risk urban Tennessee children. Sponsorships & volunteers welcome. 51 The Farm, Summertown, TN 38483  
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ktcfarm@usit.net

### TEXAS

El Paso Solar Energy Association bilingual Web page. Info in Spanish on energy & energy saving.  
www.epsea.org

El Paso, TX. El Paso Solar Energy Association: meetings normally held 1st

Thurs. of month. EPSEA, PO Box 26384, El Paso, TX 79926  
915-772-solr • epsea@txses.org  
www.epsea.org

Houston, TX. Houston Renewable Energy Group: meetings last Sunday of odd-numbered months at TSU Engineering Building, 2 PM. HREG, PO Box 580469, Houston, TX 77258  
jferrill@ev1.net  
www.txses.org/hreg/HREGhome.htm

### WASHINGTON STATE

San Juan Islands, WA. SEI Workshops. Oct. 13-15, '00: Microhydro Power, US\$250. Oct. 16-21, '00: Photovoltaic Design & Installation, US\$500. Oct. 23-28, '00: Wind Power with Mick Sagrillo, US\$500. Oct. 29, '00:

Renewable Energy for the Northwest, US\$75. SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855  
Fax: 970-963-8866  
sei@solarenergy.org  
www.solarenergy.org • Local contact: ian.woofenden@homepower.com

### WISCONSIN

Amherst, WI. Midwest Renewable Energy Association (MREA) Workshops. See ad. Call for cost, locations, instructors, & further workshop descriptions. MREA membership & participation: all welcome. Significant others half price. MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166  
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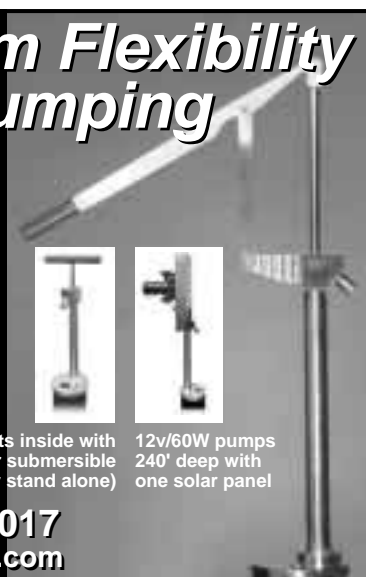
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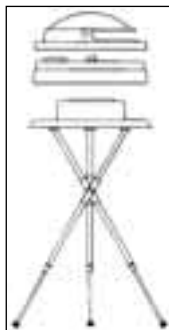
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Massive and explosive releases of methane from methane hydrate deposits may have been responsible for rapid warming events in the past. As the supply of other fossil fuels becomes depleted, many will be tempted to try to mine these deposits. They will be more expensive than other carbon based sources, since they have to be specially mined.

Mining the deposits could lead to large releases of methane, and burning the methane would release more carbon into our atmosphere. This would increase the rate of global warming well above today's projections.

This potential addition to global warming makes it even more imperative to discontinue the use of fossil fuels as soon as possible. We need to replace them with renewable energy sources. This will help to stabilize global temperatures and help to prevent potential catastrophic climate change. This must be the wave of the now. We cannot wait for the future.



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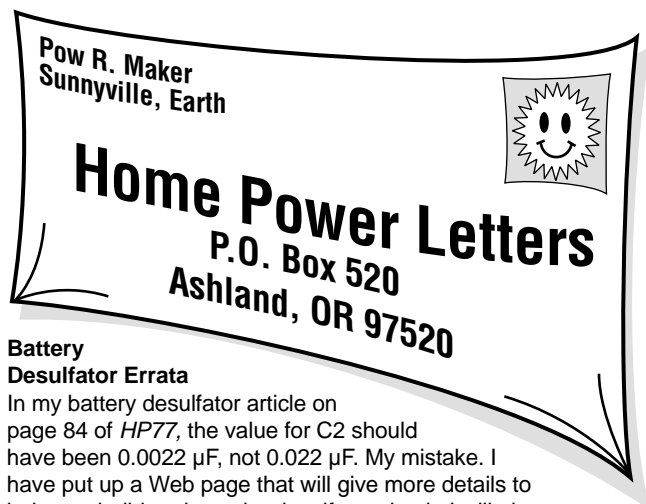
The Jackson County Library in Oregon and the Alfred Mann Library at Cornell University have all issues.

Or, get the CD-ROMs—Solar2 (HP1-HP42), Solar3 (43-60), Solar4 (61-70), and Solar5 (71-76).

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# **Battery Desulfator Errata**

In my battery desulfator article on page 84 of *HP77*, the value for C2 should have been 0.0022  $\mu$ F, not 0.022  $\mu$ F. My mistake. I have put up a Web page that will give more details to help you build and use the desulfator circuit. I will place updates there, and will add a guestbook soon to allow comments and questions to be posted. I encourage a group effort in this, since I don't have all the answers. Thanks. Alastair Couper [kalepa@shaka.com](mailto:kalepa@shaka.com)  
<http://shaka.com/~kalepa/desulf.htm>

# **Needed: Sustainable Homes in Illinois**

Dear *Home Power*, Illinois Renew and ASES are teaming up for a better-than-ever tour of solar and sustainable homes this October 14th. We're only lacking one key ingredient: solar homes for the tour! If you have a home with significant sustainable design features and would be interested in having your home included in the tour, please contact me. We'd love to have you. Sincerely, Hans Detweiler • [Hdetweiler@elpc.org](mailto:Hdetweiler@elpc.org) • 312-795-3720

# **Needed: Real Energy Prices**

The current outrage over skyrocketing electricity prices is understandable and forgivable. After all, prices in places like San Diego have doubled and tripled overnight (17¢ per KWH this week). But this should not lead to the reregulation of energy. Full deregulation and paying full market prices is essential for America's future as a competitive world player and responsible world citizen.

Unfortunately, this will not be simple or painless. As we have witnessed in industries in the former Soviet Union and water systems in England, deregulation of socialized industries is challenging and complex. Unless it is done carefully, it also places a high burden on those least able to pay for past mistakes. In England, for example, many water customers were found to be paying only 10 percent of the real cost (similar to some areas of the U.S.). When water bills suddenly began to increase rapidly, the impact on poor consumers was severe.

In San Diego those hardest hit by doubled energy bills have been the elderly on fixed incomes, where an additional \$50–150 a month is critical. Institutions with limited flexibility in budgeting such as schools and universities are also hit hard. It is clear in San Diego that a special fund should have been established to protect the poorer "lifeline" and institutional customers for the next five to ten years. It was not their mistakes that led to their current predicament.

The historical root of this latest crisis has been our desire to have a free energy lunch. To simplify things a great deal, electric utilities in the past were given many subsidies and a fixed profit based on sales. This encouraged them to increase sales and

power production, whether it made economic sense or not. If a builder oriented the lots in a subdivision so that most of the windows faced west, requiring a much bigger air conditioner for each house, this was a bonus to the utility company because it meant more power was needed.

This would enable them to justify more power production to the regulators, which led to increased sales and profits. It didn't matter to them, the utilities commissions, or the builder; but it did add thousands of dollars worth of unneeded generation capacity, expensive air conditioners, and a lifetime of air conditioning bills for the owner. These could often have been completely avoided for free by orienting the lots correctly, putting the windows in the right place, and providing proper overhangs on the windows to shade them in summer.

The utilities were never really asked to avoid environmental damage either. Our lust for more and more cheap power led to the damming and destruction of most of the rivers in the West, and air pollution and related ecosystem damage over millions of acres across the country. But "what the heck?"—electricity was cheap. The 1973 and 1979 energy crises revealed the flaws in the assumption that power would soon be too cheap to meter, but the lessons were not heeded for long.

Although the current shortages and price hikes have everyone fuming about the "greedy" utility companies, they should direct their anger at the builders who built their houses without consideration of solar orientation and natural cooling strategies. They also should be angry at their legislators and decision-makers who did little to encourage energy conservation in planning subdivision layout, house orientation and design, and commercial building design and construction. In the late 1970s, the California Energy Commission offered free advice to builders and developers to reduce energy demand and improve comfort (if true cost pricing was in place they would do it on their own).

Even earlier, I had helped the innovative design firm, Living Systems, develop climatically adapted local building codes. These were later voided by a state law that was much weaker and less effective for cooling. Since then, energy design skills and materials have gotten much better. For no increase in construction cost, it is often possible to reduce energy demand 50 percent. For an additional 10 percent increase in construction cost, it is often possible to reduce heating and cooling energy demand 90 percent.

This is nothing new. The Greeks built excellent solar homes and buildings 2,000 years ago, and even developed extensive solar developments in many cities, including Olynthus. Sadly, no one has been thinking about solar design or building energy efficient homes recently, because energy has been "cheap."

We are now thinking about these things again, but sadly, more effort is being put on placing blame than on accepting the truth—we are all guilty of wanting a free lunch. We must press on to free energy markets and true cost pricing, because if we do not complete the transition to free market prices, we will continue to build inefficient homes and buildings that are uncomfortable, unhealthful, expensive to operate, and very vulnerable to energy supply interruptions.

If we do not make this transition to a free market, we will also be left behind by other countries that do. France, for example, has had a free market in water supply since the 1850s, and it is no coincidence that French water companies are now supplying efficient and low cost water services to many countries in the

world, including a growing number of people in the U.S. It is also no surprise that arguably the best bus system in the world, in Curitiba, Brazil, is run by private bus companies.

However, we should learn from the experiences in England and the Soviet Union. We need to develop a deregulation process that protects the innocent rather than just the utilities. While San Diego Gas & Electric deserves credit for moving so quickly to free market pricing (that is what they were asked to do), the California legislature should properly be rebuked for implementing such a poorly developed strategy for such an important and commendable goal. We also need to factor in full environmental costs, something the Soviet Union also neglected, leading to catastrophic pollution.

If our courage falters and we retreat to socialized energy again, we will pay much more for power in the long run. We will also face more energy shortages in the future, and continue to be at great risk for disruption, brownouts, blackouts, and discomfort. We are in our current energy bind because developers have not stepped up to build new facilities, fearing that deregulation won't last. We need to prove them wrong, and we must put their minds at ease so that they will invest now! We also need to develop ways for energy conservation to compete against new power production, because negawatts usually cost only a fraction of new watts.

It is time to rethink the transition process without losing sight of the goal—a free market with full cost pricing. David Bainbridge, Environmental Studies Coordinator, GLS Department, United States International University, 10455 Pomerado Rd., San Diego, CA 92131 • 858-635-4616 • Fax: 858-635-4730  
bainbrid@usiu.edu • www.usiu.edu

*Hello David, Great letter. You darn near wrote my next column for me. Now I have to find something else to write about. You are correct in finding fault in California's legislature. Dereg here was set up to fail on nearly all levels. Too much attention was paid to profits for the utilities, and not enough to safeguards for consumers. Through loopholes in the methods for bidding for power and for making it available to the bidders, the energy providers (who are not necessarily the utilities) have been able to jack up the price of power. It is not the actual cost of production that drives the prices, but rather the timing during which it is made available to bidders. Some of these producers have been able to more than triple what it costs them to make the power.*

*While I am all for free enterprise (maybe some day some country will actually try it), this is ridiculous. And now that California's governor and the PUC have decided that the problem is lack of supply, they want to put the approval of new generation facilities on the fast track. That pretty much means fossil fuel-powered turbines. Bummer... Some careful thought and planning could have made renewables an important part of California's upcoming generation boom. Michael Welch*

*Hello David, I think yours is one of the most important letters that Home Power has run in a long time. I agree with you completely that our present energy predicament is largely due to the lack of reality in energy pricing. As advocates for renewable energy, we are repeatedly faced with people who say it is "too expensive." But they are only comparing renewables to the unreal price that our skewed system has put on non-renewable energy.*

*The true cost of non-renewables includes the many direct and indirect subsidies that we pay through our tax dollars. It also includes environmental degradation, health costs due to pollution, military costs to defend "our" oil, and many other unseen costs.*

*The phrase "free market" is a bit loaded for many people with an environmental conscience, and I certainly don't agree with all the connotations that have been put on the phrase. But I do agree strongly with you that we need energy pricing to be real. It is the dishonest, politically-based instead of reality-based pricing that has been largely responsible for getting us into the mess we're in.*

*This system has given a few companies enormous power over what energy we use, by granting them monopolies, subsidies, and protection. It has removed much of their responsibility by legislating liability limits and not holding them responsible for their actions. It has diluted the economic "vote" of individuals by moving many energy decisions into the political realm, where large companies have much more clout than individuals.*

*I applaud you for your clear call for a free market in energy, and your wisdom in calling for a compassionate and intelligent transition. Renewable energy will shine and prosper when the price tag on non-renewables reflects reality. And the true cost—including environmental and social costs—will undoubtedly be lower. I also urge you to consider writing more on this vital subject for Home Power. Ian Woofenden*

#### **"Green" Power?!?**

Here I sit in my solar and wind powered home looking at a post card from a company with a Web site listed as [www.green-e.org](http://www.green-e.org), telling me that my local utility (which I don't use) is going to be offering me "green power" from renewable sources. They have a chart on this card which shows where electricity comes from. Here is the breakdown:

Large hydro	.....10%
Other renewables	.....2%
Gas	.....8%
Nuclear	.....18%
Coal	.....52%
Other Fossil	.....8%
Oil	.....2%

Now according to the latest figures from the U.S. Dept. of Energy (government agency), this is wrong. But my point is not about how they play with the numbers, but about how they play on our basic impulse to do good while distorting the truth. Here is the truth:

There are over 20 coal-fired plants in the U.S. with a capacity of 100 megawatts each or larger, operating at peak capacity at any one time. 100 megawatts is 100,000,000 watts. This is a small portion of our generating capacity. According to figures we have all seen in the news lately, we are in the midst of an energy crunch.

Let's say, for arguments sake, that the utilities decided to replace one 100 megawatt block of power with a real renewable source (not hydro) using solar panels. Say they got a deal to purchase these modules at a US\$3 per watt installed cost. This would be a US\$300,000,000 investment. This is more than the bid cost of the last nuclear plant constructed in the late '70s. Have you heard of any such massive public work?

A 100 megawatt solar installation would still only provide power during the day. What about the night? Just start up the coal-fired plant for the night? *Wrong*—it takes about 12 to 15 hours to start up a large coal-fired steam turbine system from dead cold. The racking gear alone to spin the hundred-ton machine uses the power of one 500 KW diesel generator. So the figure bandied about, where a 1,000 acre portion or so of Arizona or New Mexico could be covered in solar panels and power the U.S., would cost someone about US\$12,000,000,000. Think this will happen

soon? I don't.

The present day electrical consumption of the USA is nothing less than astronomical when expressed in watts. There are so many varied loads it is hard to imagine the complexity of the system and service provided by the electrical grid. Further complicating the scenario where the USA is serviced by a renewable-powered grid is the fact that, in general, most transmission lines have losses near 75%. All in all, a very daunting task to supply even 1 or 2% of the electrical demand from these sources. And since renewables are only 1 or 2% of the total, my question is this: Where are they getting this green power to sell to all those folks on the grid?

Here is the point where it gets really sticky and I offend some folks. Remember "The Emperor's New Clothes"? Well, your green power doesn't exist. Just like suddenly Philip Morris is all community conscious and willing to do the right thing, so are your local utilities. Except they are not getting addicts off nicotine, they want more addicts hooked up to your local power injection. Without the cash kiddies, they don't exist. Sure, they would like to supply green power, but they can't afford it either, not after satisfying the investors. The bottom line would not allow for this type of monumental cash outlay, no matter if it is to save the planet. No matter how many grid-connected homes may appear, it's not nearly enough.

So it really is up to you, me, and the guy with the 5 acres who can't afford the power line, to provide our own power and take ever so much more load away from the ineffective and relentless power grids. The more we as individuals, as well as businesses and industries, make our own power and conserve, the less power they have to make, and in doing so, plant after smelly plant will eventually shut down. This is my hope. Wm. von Brethorst, Planetary Systems • brethorst@3rivers.net

*Hi Bill. There's a couple of things I might add. First, green-e is not a power company, but rather a non-profit that certifies companies that meet their qualifications as sellers of green energy. Unfortunately, their qualifications bite because they lead people to think their power purchase decisions are actually doing some good, when it usually does not. See my Power Politics columns in HP64 & 65, and the letter to editor and response in HP67 for more info.*

*It is true that coal plants and other water-boiling plants take a long time to ramp up their power production from cold start. Nuclear takes the longest to shut down and restart. But you will find that most modern plants being built are natural gas turbines which can ramp up production relatively quickly. You will be seeing a lot of these plants being built in the next few years.*

*I pretty much agree with your comments, but you use the high cost of utility-scale renewable energy to justify getting off the grid as an alternative. When you think about it, home-scale RE costs significantly more than utility-scale RE, making it even more unlikely that the millions of households that want green power will be able to pull it off. Definitely it is the best way to go, but still unlikely to happen.*

*With regard to the reality of folks using utility-scale green energy, the only way it can truly happen is by going with a company that is building new RE sources. While not perfect, the energy program that powers the Redwood Alliance office is as green as any other I have seen. We are using Green Mountain's Wind for the Future program (See HP63 Power Politics). They also have a Solar for the Future program which has been building on-grid PV*

*systems in California and Pennsylvania.*

*Watch out, though, many companies are calling large-scale hydro a green resource, which is not OK by me. Also, at least one of the major green energy players in CA is promising to develop new "RE sources" using geothermal geyser power. To do that, they want to develop a particular site which is unspoiled wilderness and sacred to several northern California Native American tribes. That is also unacceptable to most in the environmental movement.*

*The sad fact is that in this country we need to vote with our pocketbook—the politicians sure aren't going to take care of it. Until each of us gets off-grid, if we write that check to the companies that are building more RE sources, our votes will begin counting and finally begin adding up. Yours for an RE future for everyone, Michael Welch.*

## What to Do?

Hello Home Power, We live in a condominium complex and can't even store firewood in our carport. What would some options be for us to consider regarding renewable energy? We'll probably have to submit to the homeowners association, but at least we can ask. Thanks for any advice. Joe & Merci Schuessler, PO Box 806, Aptos, CA 95001 • mercedina@webtv.net

*Hello Joe & Merci, Well, the best place to start is with your appliances. Are you using incandescent lighting? If so, consider compact fluorescents. How about your TV, VCR, stereo, and microwave? Are they on plug strips, or are they phantom loads, sucking up energy 24 hours a day?*

*The essence of using renewable energy is effective use of electricity. Making your home as efficient as possible makes RE more practical, and gives you an immediate reduction in your utility bills.*

*Next, consider installing a MicroSine PV system. This consists of two PV modules (about 1 meter square area) and a MicroSine inverter. This setup will put about 400 to 500 watt-hours of solar electricity onto the utility grid each day. It can spin your utility meter backwards and reduce your power bill.*

*The two PV modules can be placed on a patio or on a balcony, or even mounted over the edge of the balcony or window. All that is necessary is that they see as much sun as possible. This is a battery-less system, so there are no hassles with batteries. Cost is about US\$1,000, and the PVs carry a 20 to 25 year warranty, so they'll continue to make solar-electric power for quite a while.*

*I don't know what's wrong with some homeowners' associations. Karen's mom just moved into a new house and the local homeowners' association will not allow her to use one of the greatest energy savers ever—a clothesline in the back yard. Enough is enough! No wonder this country has energy and environmental problems! Richard Perez*

## Hostile Skies

Hello Richard, You've probably gotten a million of these messages by now but... To get from Milwaukee to England, it took us 48 hours, five airports, two bus rides, a night in a motel, and \$500 for "extra" airfare. And the conditions on the plane violated Geneva Convention rules for treatment of prisoners. I've had really good luck with Amtrak, east of the Mississippi. John R. Surber, Milwaukee, WI • surber@csd.uwm.edu

*Hello John, My Ozonal Notes piece on air travel seems to have hit a nerve among many Home Power readers. I've received many air travel horror stories. I'm with you—let's stick with ground travel! Richard Perez*



### The Not So Friendly Skies

Richard, Just got the Aug/Sept issue of *HP*, and as always, I enjoyed reading it. However, your unfortunate "hosing" events during your trip to MREF in Madison hit a bit close to home.

As your youngest brother, and having worked in the airline industry for over fifteen years, I can tell you that the traveling public never sees half of the FUBAR situations that really occur. I am sure that your delays were attributed to such factors as Betty Sue the flight attendant calling in sick because she had a hangnail, or maybe that Avionics part just seemed to have gotten lost by the overnight delivery company. It also could have even been as seemingly inconsequential as someone forgetting to sign off on a piece of paper. You would be surprised as to the actual reasons that cause schedules to crater.

One of the biggest problems is that the airlines—and this goes for the majors all the way down to little bitty charter guys—schedule their equipment too tightly. All it takes is one small, unexpected event, and all hell breaks loose! I have personally seen this many times, and have spent many sleepless nights trying to rectify those situations. The only time I have been afforded any possible relief for this tight utilization of resources was with a small charter outfit that I worked for back in the late '80s. These guys were visionaries, and actually kept a spare aircraft and two hot crews set up at all times for just such occurrences. Needless to say, they were eventually squashed out of existence by the major carriers. But I will say that they had guts, and went down, so to speak, fighting.

Another kicker is the airlines "spoke and hub" flight routes. That flight to Chicago to get to Madison was a perfect example. It does not make much sense, even to a seasoned veteran of the industry, why you have to fly from Dallas *through* Chicago to get to Orlando!

When United arranged for the 747 to do the short hop from Denver to San Fran, I can guarantee you that there was a manager who got the butt chewing of his life in a morning operations meeting! I am sure United lost their shirt on that run!

The agents in customer service who are on the front lines during these battles have to have the patience of our mother. They take the brunt of the frustration of the weary traveler, and only get further insulted when their paycheck arrives.

One saving grace is the airport concessions, although I hate to say how many all-beef quarter-pound gut bombs I may have consumed in my time. It is still amazing how they complicate your frustrations by not allowing the indulgence of a smoke during such trying times. If you do find that one establishment that allows you to light up, you usually don't have to because just breathing in the secondhand smoke of the umpteen other smokers suffices. You were truly lucky to find that place in Denver that allowed you to smoke. In Atlanta's Hartsfield airport, they have the grace to provide actual smoking lounges on three of the five concourses, but this is not the norm. Maybe they provide such places in Atlanta because Delta has the worst record of flight delays out of Hartsfield, their home base. I guess it must keep the riots to a minimum.

I think you summed up air traveling experience in the next to the last paragraph of your piece, "fly early, expect delays, believe nothing, and carry a flask of strong drink." The only thing I would add is to carry along a blow-up pillow for the long sitting sessions that seem to accompany most air traveling experiences nowadays.

Having been in the industry and seen the behind-the-scenes shenanigans as well as having actually been "hosed" by United Airlines in the past more than once, also in Denver, I too am grounding myself whenever possible! Craig Perez  
valkyman@bellsouth.net

*Hello Craig, and yes, for the benefit of our readers, he really is my youngest brother. Thanks for the explanation of why things get hostile in the friendly skies. While air travel is so seductive, promising us the opportunity to travel very long distances in short periods of time, I think this promise is largely unfulfilled. I liken the situation to installing a supercharger on a car with a clutch that slips. I'm with you, let's stay grounded! Richard Perez*

*Howdy John & Craig, Just as the Supreme Court offers minority opinions in response to their majority rulings, I'd like to get a couple of cents worth in here. Personally, I have not had as many problems with my flights over the years. One of the jokes around here is that we should try to avoid flying with Karen & Richard, because something usually screws up their itineraries. It has nothing to do with them, really. Karen books everyone's flights, even mine. It seems to be a matter of luck and coincidence.*

*What is difficult for me and some others on the crew is that ground transportation makes us spend many days on the road when we travel to far-away places. It is nearly impossible to do any of our work while traveling in a motorhome. Traffic and weather problems and differences in driving styles stress us out. Safety and rest are always concerns. Several days driving with a monolithic can full of bodies can be trying and tiring. And just like any other family, squabbles pop up that add into the mix, although as a group, we get along very well.*

*When you add up the time spent and the tiredness of the crew, and compare it to the trials and tribulations of flying, I vote for the airlines.*

*If we cannot fly, we should try using the rails supplemented by van rentals from the nearest point of disembarkation. While not taking less time than RV driving, it would allow us to arrive safe, rested, and possibly even get a little work done on the way. And if any of us need space from the others, there's always the other end of the train. I may end up in the caboose after submitting my minority opinion, though... Michael Welch*

### Microhydro and Fish

Hi guys, I was re-reading *HP77* the other day and realized that our email discussion regarding microhydro structures in fish-bearing waters had made it into print. We're gratified to see that the subject is being taken seriously. After all, *HP* is about making power. It's not a nature magazine fer cryin' out loud, and we realize that worrying about a handful of fishies is somewhat of a distraction.

Having said that, I've gotta share some knowledge Patti and I have gained since this discussion started, since it bears on comments made by *HP* staff. In the last couple of months, we've been thrashing about in the infamous western Washington brush, ground-truthing DNR base maps for the tributaries near our residence. DNR base maps show all rivers down to the tiniest tributaries, and are marked as to whether the waterways are fish-bearing or not. Ground-truthing refers to the process of actually looking in the streams for fish, and checking the accuracy of the base maps, which are often in need of correction.

We've found salmonids (coho and cutthroat) hanging out in ridiculously small waterways. In one tributary, we found fish two hundred feet below the point where water first appeared at the

surface. Other tributaries were not exploited as far, but in all cases we were surprised at the persistence of the fish. Fisheries biologists have since told us that our findings were pretty typical. You couldn't spin a toy pinwheel in these flows, much less a real impeller. Bob-O's comment that most microhydro go in small creeks with no resident fish population concerns me. From what we've seen, it's the other way around—microhydro becomes infeasible long before the creek stops supporting fish.

There's another thing I have to respond to. It was pointed out that adults would have no difficulty getting past the small dam under discussion. This is probably accurate. However, juvenile passage was never mentioned. We're in the process of replacing a culvert on our property with the help of grant money from USFWS. The culvert impedes but doesn't stop adult passage. It does stop juveniles from moving freely up and down the stream in search of food and shelter. This is a critical measure of juvenile survivability. The fact that we're getting funding when adults can get past the barrier is an indication of the importance placed on this part of salmon recovery.

OK, I'm done. Thanks for listening. I'm sorry for trying your patience. I don't want to dilute the energy that all of you dedicate so effectively with tangential issues, but this fish stuff has become really important to us and we had to throw our two cents in. Bill & Patti Barmettler, PO Box 1462, Chehalis, WA 98532 360-748-8265 • bpbar@juno.com

*Dear Bill & Patti, Great letter. I can't—and won't—challenge your findings. I must, therefore, agree with them! My experience is with creeks far to the south of you. When the water gets as low as you describe, it also gets too warm to support most fish, especially salmonids. Also, it rarely rains here between June and October (unlike your neck of the woods where folks grow webs between their fingers and toes!), so there is little if any recharge or cooling of the puddles. I can see that from Washington up the Pacific coast, it's a fish of a different color. Clearly folks up your way have to be extra careful to provide passage. My concern about your letter is this:*

*While nearly all the fish in creeks in your area are salmonid, in most other areas, it just ain't so. Not that other fish don't deserve our respect and attention, but they generally aren't as endangered as salmon and steelhead. Most folks couldn't tell a salmon fry from a french fry, and they aren't very likely to catch and kill one to find out.*

*I'd hate for folks to get gun shy about a little microhydro plant and stay on fossil fuels, nukes, or burning salmon from BDH (big damn hydro) just because they need to create a very small impoundment (often the best protection for little fish), which might or might not impede feeding. When it comes time for the fish to run downstream to the sea, I don't see the problem.*

*The hard truth is this. While it's our absolute moral, God-given duty to tread lightly on the earth, tread we must or perish. It's a question of doing the best we can with what we've got to work with this time around. Ya know? Thanks again for your letter. Best, Bob-O Schultz*

## Old Fridge—New Fridge

Dear Eric, Richard, and Larry, I read your exchange (HP76, page 148) about old refrigerators with great interest, and want to share a bit of my own experience with these appliances, which parallels Eric's findings to some degree.

I became interested in old refrigerators a few years back, just as the electric utility campaigns to get them replaced were getting

underway. Three years ago, my wife and I moved to Berkeley, California and found a studio apartment. We were settling in, trying to make sense of the unfortunate layout of the kitchen, when it occurred to us that substituting a smaller fridge would let us use the available space more efficiently. Determined to find the most energy efficient model available, I researched the matter carefully. Exact size, method of defrosting, country of origin—I was willing to consider most any combination. Real Goods provided specs on the Sun Frost models, and the Association of Home Appliance Manufacturers (AHAM) gave us an overview of much of the rest.

I even got a whiff of the curious world of Energy Guide labels. When the neighbors' fridge died in the middle of my search, we gladly donated our (and their) landlord's 19 cubic foot mustard-yellow behemoth, hefting it down and then up narrow flights of stairs. Without a fridge in our flat, the pace of my search quickened. I selected a 9.5 cubic foot manual defrost Sanyo (built in Southern California, incidentally) with a single exterior door and a smallish freezer compartment.

Somewhere along the way, I picked up the requisite pieces to assemble a meter just like the one Eric built. After two and a half years of metering and a bit of tinkering to get the freezer to properly freeze ice cream, I can say I have been very pleased with the purchase. The fridge consumes 167 KWH/year, for an average daily rate of 456 WH. I concede that with a skimpy 1-3/4 inches of PU insulation, a Sun Frost in sheep's clothing I have not (quite). But as a graduate student with a less than stable source of income, the payback (energy costs saved/purchase price of fridge) has been most rewarding. At northern California electricity prices (10.4¢ per KWH plus 2.1¢ per KWH premium for deregulated wind energy), the fridge has already paid for itself. The old yellow one had been gobbling up roughly 3.3 KWH per day.

But, I have veered from Eric's insight about the old model in his kitchen. Having done a bit of metering on my grandmother's 1946 Leonard fridge, I finally was able to purchase a 1947 Frigidaire a year ago (5.8 cubic feet). No, it's not in my kitchen—there's no room and I wouldn't know what to do with the extra fridge space. I lent it to a lab at UC Berkeley where the research folk keep their sandwiches and beer cold. With another homebuilt 120 VAC analog meter, I've been tracking its consumption as well. 240 KWH per year or 660 WH per day. Not a lot of deterioration in performance over 53 years! This one cost me a mere US\$70, the meter US\$7. The miserliness with which both models consume electricity is proof enough for me that the industry and households could do better producing and choosing less hefty appliances. As Eric pointed out, nearly all the fridges found in your local appliance dealer's showroom (and all the Energy Star models) don't come close to either one.

In conclusion, I want to comment on Eric's enthusiasm for reducing loads to scale back the design of a renewable energy system. While 130 KWH per month is impressive, why stop there? I'd like to see someone organize a competition for the lowest household energy bills and how they were achieved. For the U.S. as a whole, average per capita residential electricity consumption currently works out to about 11.5 KWH per day or 350 KWH per month. With a bit of tinkering and some slight changes in behavior, we've managed to drop below the average by a factor of 30, and we're not ready to stop just yet. Reuben Deumling, deumling@socrates.berkeley.edu

*Hello Ruben. Great work and that's the attitude! Every watt-hour saved is a watt-hour that doesn't need to be generated, transmitted, and, if you are off-grid, stored. I've seen families of two who are content and happy with just two PV modules.*

*On the subject of refrigerators, I think that this industry is finally waking up. When Karen's mom moved into her new on-grid house, we bought her a new refrigerator/freezer. This 18 cubic foot Maytag has all the conveniences, such as easy to move shelves and auto defrost. It consumes about 1,180 watt-hours per day, and the cost was US\$799. I applaud the refrigeration industry for finally putting their products on an energy diet.*  
Richard Perez

### Right Livelihood

Dear Editor, Ben Root's "right livelihood" piece (HP78, page 8) really struck a chord. Although it's been a while since I was saving lives as a Coast Guard radioman, my search for the perfect "socially responsible" job continues. In his editorial, Ben laid out a clear and understandable blueprint for choosing the right path. Such writing inspires not only those of us in the renewable crowd, but acts as a catalyst for positive change throughout the general populace as well—keep up the great work! Roger J. Wendell WB0JNR, Aurora, Colorado

*Thanks Roger! The daily grind is worth it when we have a positive effect.* Ben Root

### Budget Surplus to Solar Power

I am a subscriber to *Home Power*, and I must say that I look forward to its arrival like those in the "old days" looked forward to the arrival of their Sears catalog during those long, cold, dark wintry nights. It's funny, more and more over time I've noticed that I'm becoming significantly more hard core environmentally proactive. I was listening to NPR the other day and they were talking about how to spend the budget surplus. I thought that it would be a real boost to our country, economy, and environment to offer every homeowner an opportunity to draw down a percentage of this money to spend on producing their own home, apartment, or living area power.

This "subsidy" would cut into the constant quest for the acquisition and consumption of energy that fuels the huge imbalance that we are suffering from societally. The money saved would help the grid, "energize" the economy by encouraging industry to produce in a constructive cooperative way, decrease our dependence on foreign energy, and radically reduce military spending, which is linked to protecting our interests in this area. Last but not least, it would go a long way towards beginning the healing process of our world by engaging us in raising our consciousness, by learning how to use our energy wisely through good stewardship and cooperation. Does this sound too good to be true, or have I made too many left turns lately? Best, Ben Macri • benmacri@home.com

*Hello Ben. I must have taken the same left turns because this sounds like a great idea to me too. For example, consider a small PV system consisting of 100 watts of PV and a MicroSine inverter. Such a system exists today and costs about US\$1,000. If each of the USA's some 93 million homes were to install such a system, we would have a generating capacity of 9.3 trillion watts of electric power, and produce over 30 trillion watt-hours of energy daily. Each of those PV installations would eliminate about 2 metric tons (4,400 pounds) of CO<sub>2</sub> released into the atmosphere yearly. Sounds like a plan to me...* Richard Perez

### Ecofan

Hello Kathleen, We read your article about the Ecofan and

thought it sounded like a good idea. Caframo told us that we had a distributor not 25 miles away, but they have yet to negotiate prices and shipping costs. After some trans-Atlantic phone calls, we had an Ecofan shipped over to Stocksbridge, South Yorkshire, England, via an uncle who lives in Ontario.

We had to wait a week for a suitably cool day to warrant having a fire, which we lit at about 6:30 PM. What a difference this little fan makes! I know we are not in the depths of winter, but—my word—the room was warm within minutes of the fire being lit. In fact, it got so hot that my partner had to go outside for some fresh air. It wasn't really that cold, but we wanted to see this fan in action. We have a smaller stove in the other room and will be purchasing another fan soon. Could you let us know what a cord of wood is, like a fathom is six feet. We realise that a cord must be a measure of an amount of wood, but what?

We have a Air 404 wind genny, and a couple of photovoltaic panels that charge a small battery bank to power our household lights. We've just bought *From the Fryer to the Fuel Tank* with a view to manufacturing our own fuel to run a large generator to meet our household needs. The costs are nowhere as economical as your methanol—75 cents a litre, while ours is £5 a gallon—but we can try!

Costs for RE products are generally double when bought through distributors over here. We paid about £55 for the Ecofan via our relative in Ontario. The chap 25 miles away wants to sell the fan for about £85. Ripped off or what!

We moved to this semi-rural location two years ago, and are trying in our own way to be green/self sufficient/money saving and get out of the rat race. Anyway, thank you for a cracking magazine, and keep up the good work. Regards, Lyn & Richard Jarvis, Wellhouse Farm, Hunshelf Bank, Stocksbridge, Sheffield, South Yorkshire S36 2BS England • Lyn.Jarvis@btinternet.com

*Hi Lyn and Richard, Bob-O and I are having a booth at our local county fair next week. I figured out how to set the Ecofan on a small solar cooker and make it turn without cooking it. It looks pretty cool. We gave a couple of Ecofans away as Christmas gifts last year to friends with wood stoves. They all really liked them. One guy's wife was telling us that her husband kept moving it around on the stove to find exactly the most efficient position for the fan. It certainly makes me feel good to know that people like you are getting some good out of my column. A cord of wood is 8 ft. long by 4 ft. wide by 4 ft. high (2.44 x 1.22 x 1.22 m), or 128 cubic feet (3.63 m<sup>3</sup>), cut, split, and stacked. Kathleen Jarschke-Schultze*

### Energy Efficient Appliances

Dear Kathleen, Thanks for the info about energy efficient appliances you provided in your most recent *Home & Heart* (HP78). My wife and I both enjoy your column. I have found that the ACEEE Guide to Energy Efficient Appliances is very good for comparing models. I purchase a new guide almost every year just to keep tabs on energy efficiency trends, even though I am not currently in the market for any major appliances. However, the best source of this information that I have ever found is the Canadian government's department of Natural Resources Web site: (<http://energiguide.nrcan.gc.ca>).

Along with all the standard basic educational info, this site lists the actual energy use in watts for each appliance. It also provides a calculator to determine the actual lifetime cost of the appliance (sticker price plus energy cost over the expected life of the appliance). This allows a consumer to make truly informed purchases.

The closest our US Environmental Protection Agency comes is its Energy Star program, which is something of a joke in my opinion. For many appliances, the vast majority of models are awarded the "Energy Star" label even though they may differ greatly in energy demand. I believe this is the result of the pervasive influence of corporate lobbying on our political system. In order to get the major industries to grudgingly acquiesce to the system, the DOE sets the standards at a very liberal level to make everyone happy. The result is that industry does not have to really strive to improve the energy efficiency of its products.

Even a cursory review of the range of energy use among different models and manufacturers (available at the Canadian Natural Resources Web site) of a given appliance reveals that the vast majority of appliances could be much more efficient simply by applying current technology! I believe the Energy Star label should be reserved for the single most efficient model in each size and style category. This would make it a truly special designation and manufacturers would have much more incentive to innovate in order to achieve it.

Another flawed source of info in the U.S. marketing system is the Energuide labels on major appliances. Although better than no labels at all, they are sometimes (intentionally?) misleading. The case of washing machines provides a perfect example. The Energuide labels for traditional top-loading machines do not include the energy use of very efficient front loaders such as the Maytag Neptune. Energy efficient front loaders (actually horizontal axis machines, including the Staber) are only compared among themselves on the Energuide labels.

When consumers are reading these labels (if they are reading them), they are trying to compare the energy use of different washing machines, not one style versus another. People could be easily misled into believing they are buying a very efficient unit that actually uses three times as much energy as the most efficient model available! These are a few of the pitfalls I have learned about in my quest to outfit my off-grid home with the most energy efficient appliances available.

Despite these problems, we have been able to outfit our home with all the modern name-brand appliances from mainstream retailers simply by taking the time to learn what to look for, and doing so. I hope more and more people will do the same, and this is what will really motivate manufacturers to increase energy efficiency. Thanks again for your informative article and thanks especially to our Canadian friends! Joe Schiller, 2951 Chapel Hill Rd., Clarksville, TN 37040 • schillerjoseph@netscape.net

### EV Update

Michael, I thought I would write you and give you an update on my EV situation. In my article in *HP77*, page 92, I decided that although an EV definitely made sense, I needed too much range to be able to use an EV right now, and I couldn't afford to build one that had the needed range. I received a lot of email from folks who were encouraged to look at EVs more seriously because of my article, and because of that, I consider it a success. Mostly it was them who encouraged me to post this follow-up letter.

Shortly after that issue came out, my employer said I could charge up at work if I wanted to. This cut the range I needed down to about 30 miles, which was easily doable. They even reserved a parking place by a 110 VAC receptacle. Towards the end of July, I purchased a used 1986 Ford Escort conversion through the EV tradin' post (see photo).



When it arrived, I discovered that the charger was broken due to several years worth of road grime building up inside and corroding the circuit boards and wires. (A note to all BC-20 owners: seal up your circuit boards with some sort of insulating brush-on material, because the fan blows everything right over the board.) I ordered a backup offboard charger, and I've been driving the EV for running errands around town. Yesterday I received my repaired BC-20 back from K & W. They were very helpful. I hope to start using the EV for my commute in the next couple of weeks. Then I can take at least a small bite out of that haze that seems to plague Tulsa during the summer. David Brandt • davidbr@nordam.com

### Solar Sustainability Challenge

I am thrilled to announce the Solar Sustainability Challenge, a solar "un-race" to take place at a time and place yet to be decided. The purpose of this event is to conduct a real world simulation of daily living, with solar transportation and sustainability in mind. This will not be just a race, but a group of events going from sustainable community to community, using solar cars as a sole means of transportation. Isn't that what we do every day in our gasoline-powered world?

I see no better way to spread the use of solar knowledge and know-how, and to accelerate and promote the introduction of sustainable and renewable technologies in communities around the country. This un-race could go anywhere around the U.S., Canada, or Mexico. The idea is to move—using solar energy only—from one community to another. Once in a community, participants would rest, maybe do some part-time work related to sustainability and solar energy, eat organic food and/or help in its production, get the solar car ready, and move to another community.

The winners will be the teams that can show the smallest human footprint, according to the premises set forward by Dr. Wackernagel from the University of British Columbia. Prizes will be a shining silver trophy... No, not really—how unimaginative! I would love to give the winners a new set of organic hemp or organic cotton clothes from Patagonia, or FoxFire, or a years' organic food supply from Whole Foods, or a new set of solar panels from Uni-Solar.

*Home Power* has graciously offered to publicize the Solar Sustainability Challenge in its pages. The biggest unanswered question is how to put the solar cars safely on the existing

infrastructure—roads that are entirely designed for 4,000+ pound gas-guzzler SUVs and 80,000 pound tractor trailers—without having the need for a fleet of gasoline-powered vehicles behind and in front of the solar cars during the un-race. That really defeats the purpose of solar transportation. It is also the biggest challenge. Another challenge is solar tires that are inexpensive and will reliably last for a couple thousand miles. How about that, Michelin, Dunlop, Goodyear?

Our society is totally unsustainable now. Just to give you an example, imagine giving everyone in the world the same number of cars per capita as we have here in the U.S. We would need the iron, steel, rubber, and oil to produce and run these cars. We would also need lots of water—it takes about 40,000 gallons to make one car, and this is the same H<sub>2</sub>O we drink. Then there's the air—the exact same brand we breathe. Looking at the whole picture, it would take the resources of not one, not two, but about six planets to do this. And in the end, we would no doubt leave them all as polluted and wrecked as we are leaving this one. Wow!

Let's make a solar and sustainable future for ourselves. A place where we can work, live, drink clean water, breathe clean air, and still leave a free and viable future for our children's children and all the living creatures that share the planet with us and make life possible here.

Please contact me as soon as possible if you would like to participate, help organize, sponsor, or contribute suggestions or resources for the race, or if you can get your community, organization, university, college or company involved and organized. We will soon be writing a set of preliminary rules, which will be published in *Home Power*. America is the one place in the entire world where revolutions not only are still possible, but happen. Tony Pereira, 1501 E. Carson St. #15, Carson, CA 90745 • 310-549-3077 • bk931@lafn.org

### Net Metering in Iowa

Richard, I recently sent you a copy of an op-ed I had written for the Cedar Rapids Gazette concerning net metering in Iowa. Your response to me was that maybe this would cause some mild reaction. Well, I never have been so excited (or nervous) since 1992 when the first IRENEW Energy Expo was first established. The response was more than I expected.

The premise of my op-ed was twofold. First, net metering is legal in Iowa, but is constantly being stonewalled, mostly by MidAmerican Energy. Second, a school district in Iowa is being kept from net metering their 750,000 watt wind turbine by Alliant Energy (give all your electricity to us—the utility—first, and we sell back to you what you need!). My op-ed was printed on Wednesday before our Energy Expo, and by that Friday, fur had started to fly.

The Iowa Utility Board (IUB) issues "rules," not laws. What this means very simply is the utilities can keep (and have kept) alternative energy rules tied up in court forever. So when people assume that Iowa is one of over thirty states in our country to have legal net metering, forget it. The IUB will not enforce their rules until the legal process finds in their favor. This means net metering in Iowa is in limbo (not legal and not illegal). This legally delays the net metering process to infinity.

After my op-ed, the IUB received so many calls that I thought they were going to personally rip my throat out. Instead, by that Friday (two days later), my op-ed had caused a legal procedure to start to rewrite the rules so there could be no misunderstanding. Alliant

has received a waiver so the school district can net meter. No one has told me why the energy company gets the waiver for something that it is required to do in the net metering rule.

What my letter did in two days (evidently) was to cause a legal rewrite of the rule so there could be no misunderstanding by the utilities and the public of where the IUB stands on this subject: "The intent of the original rule written by the IUB was not to exclude alternative energy producers." Here's a shortened version of the letter:

### Letter to the Cedar Rapids Gazette

The tremendous rise and minor fall of gasoline prices this spring and summer is a major reason to get involved in energy issues. A second reason to become involved is the prediction that the cost of heating with natural gas will go up this fall and winter. The third reason to become involved in energy issues is because the two biggest electric utilities in Iowa are stonewalling "net metering."

Net metering is an easy, legal way to reduce your electric bill. It is an arrangement between an electric utility and a customer who wants to produce some (or all) of his or her own electricity (usually using solar or wind energy). The cost of electricity from the utility is offset, in whole or in part, by the value of electricity produced by the consumer.

This is an issue entirely different from electric deregulation, which will again show its ugly head this year. The utilities' unreasonable and unfair behavior concerning net metering has been going on for seventeen years, but most recently concerns the Eldora-New Providence school district.

Iowa is one of over 30 states with laws and/or regulations making this production and exchange of electricity legal. One method of net metering can be a direct exchange between the customer and the utility, where the electric meter can run in either direction. MidAmerican Energy is so predictable about this subject that it has asked the federal government (again) to rule on this arrangement. MidAmerican has been keeping this in court since 1983. Last winter, the company even asked the Iowa Supreme Court for a ruling. Now here is the arrogant and unfair part: It is legal to net meter in Iowa, but the utilities are just saying no.

Iowa's net metering bill specifies that the metering arrangement is up to the customer. Not in this case. This would fit the old saying about having your cake and eating it, too. The utilities want you to buy the oven, make your own electricity, bake the cake, and then charge you to eat your own cake. You put up the 750,000 watt (big) wind generator, give us the electricity and then we will sell it back to you. To have to sell all your electricity to the utility first is unfair, unreasonable, and not a legal requirement for net metering in Iowa.

According to Paul Gipe (a national wind expert from California), the electric utilities across the United States are "obstructing wind and other alternative energy interconnections by unreasonable and unfair requirements." In the case of MidAmerican and Alliant, it also appears that "might makes right."

One thing you and I can do is to call the Iowa Utilities Board and explain how unfair and unreasonable MidAmerican and Alliant are in regard to net metering (specifically with Eldora-New Providence schools). Otherwise, net metering will never survive, even though it is legal in Iowa. Tom Snyder, IRENEW Board Member, Dyersville, Iowa • studegh@earthlink.net

## Eco-Laundromat

Hi Folks! Part of a dream is coming true for me—a dream of an inner city community centre for poverty-ridden areas, a human-powered, solar-assisted, wetland remediated, water-recycling, heat-recovering laundromat. A small group of volunteers will be gathering this summer at Earthaven Ecovillage to create prototypes linking salvaged exercise equipment with laundry equipment.

I'm sure that some of you have experimented with hand-cranked, pedal powered, pulleyed, and other non-electrical devices to perform needed work. Some of you may even have read Alan Weisman's book, *Gaviotas*, in which he describes that community's use of children's playground equipment to pump deep groundwater up for fully supplying their community centre's water needs.

I know the ingenuity of *HP* readers, and I'll bet the thought of expending effort just to exercise might generate some amusement. I want to generate something else: community spirit, healthy bodies, and free laundry facilities where they're most needed (but don't lose that sense of humour). Several pedal-powered washing machines have already been designed in different parts of the world. What about hooking up a rowing machine to a laundry spinner, or pumping units of water instead of lifting weights? How efficient would a solar kiln be at "finishing" spun laundry? Could a children's rocking toy run a heat exchanger?

If you have design ideas, time for home tinkering, or a sudden urge to volunteer a week of your creative time at Earthaven, we'd be delighted. If you have a windfall, maybe you'd consider getting a fund together to donate some new high-end, energy efficient equipment for reconfiguring and comparing with the salvaged contraptions.

Earthaven intends to use their laundromat as a showpiece, linked with greywater cleaning ponds also filled from their café wastes. Their high profile, many visitors, and membership in the Global Ecovillage Network could help this idea move. Would any of you like to help, too? Jackie McMillan, 70 Cornell Ave., #8, Kitchener, ON N2G 3E4 Canada • Message phone: 828-669-8879 Earthaven phone: 828-669-6760 • jaiem@look.ca

*What a great idea, Jackie! I hope our readers will support you with ideas, money, and time. And I hope we'll all be able to read about your success in a future issue of Home Power! Ian Woolfenden*

## CO<sub>2</sub>

I just finished reading Don Loweberg's column in *HP77*. As usual, his text is provocative and timely. However, I would like to balance his blanket statement that all CO<sub>2</sub> is bad CO<sub>2</sub>.

There should be no question that CO<sub>2</sub> is a major pollutant in the United States and abroad. But elimination or mitigation of CO<sub>2</sub> production is not likely to be accomplished by blind promotion of wholesale conversion to solar generation of electricity and heat—not at today's cost per unit of solar capacity, and at the current fickleness of solar availability in most parts of the world.

There are three issues that govern how we should look at CO<sub>2</sub> and the practical need for energy in a typical residence in a developed area of the world. These issues are the relative CO<sub>2</sub> production per unit of heat released by various commercial fuels, the relative economics of renewable capacity versus traditional sources of power, and the practicality of best technology integration to obtain the best features of combined technologies.

It is important to note that not all fuels are created equal when it comes to CO<sub>2</sub> production. For example, combustion of 1 pound of carbon and 2.66 pounds of oxygen forms 3.66 pounds of CO<sub>2</sub>. This process releases about 14,600 btu of heat. On the other hand, combustion of 1 pound of hydrogen with 8 pounds of oxygen forms 9 pounds of water. This process releases about 62,000 btu of heat. The hydrocarbon makeup of the fuel determines how bad the fuel really is when CO<sub>2</sub> production is the preferred unit of measure.

Coal, which is the dominant fuel for centralized utilities, is a demonstrated bad CO<sub>2</sub> actor because a typical bituminous coal will contain about 80 percent carbon by weight and only around 6 percent hydrogen. This means that coal will favor the first combustion process described above, and will produce huge quantities of CO<sub>2</sub>, regardless of how "perfect" the combustion process might be.

Natural gas is on the other end of the spectrum. Composed of approximately 80 percent methane (CH<sub>4</sub>), natural gas combustion produces a combination of CO<sub>2</sub> and H<sub>2</sub>O, or water. If we burn 1 pound of methane with 4 pounds of oxygen, the result is 2.75 pounds of CO<sub>2</sub> and 2.25 pounds of water. The heat liberated is about 23,850 btu.

If we look at the dominant 80 percent carbon content of coal and the dominant 80 percent methane content of natural gas, we have a fair basis for comparison. The carbon produces 3.66 pounds of CO<sub>2</sub> while liberating 14,600 btu of heat. The methane produces 2.25 pounds of CO<sub>2</sub> while liberating 23,850 btu of heat. Therefore, the methane produces 94.33 pounds of CO<sub>2</sub> for every 1,000,000 btu of heat generated. The carbon produces 250.68 pounds of CO<sub>2</sub> for every 1,000,000 btu of heat generated. This means natural gas combustion will generally produce about 38 percent as much CO<sub>2</sub> as coal combustion per 1,000,000 btu of heat released. A similar ratio will be developed by propane (C<sub>3</sub>H<sub>8</sub>), a preferred fuel among renewable energy users.

It is not hard to see that a complete conversion from coal combustion to natural gas combustion would instantly cut U.S. CO<sub>2</sub> production in half. Furthermore, natural gas combustion is relatively "cool" and NO<sub>x</sub> pollution would be dramatically reduced as well. This is why natural gas is increasingly popular in most areas of the U.S., so much so, in fact, that natural gas supplies nationwide shifted from surplus to demand during last winter in the East.

The point of this simplified view of the combustion world is that there are many sources of CO<sub>2</sub> production, both man-made and natural. Remember, utilities burn a lot of coal. Transportation burns a lot of gasoline and diesel fuel. All of these fuels are carbon rich. Mitigation of man-made CO<sub>2</sub> sources by eliminating coal combustion and the use of other high carbon content fuels is a good thing. Outright elimination by political fiat or grassroots agitation is not only virtually impossible, it is probably not practical while maintaining anything close to our current standard of living. I think Don's viewpoint is somewhat skewed and gives *Home Power* readers a distorted look at how they might view the specification of their PV systems and their place in the overall energy picture.

If we shift our scrutiny to economics and take another look at solar thermal and solar electricity versus traditional sources, we will find that the power production world is not full of idiots. Where money is the principal means of trade, the dollar will naturally seek out the low cost opportunity. In the case of electricity generation, the traditional, centralized utility can give us grid power for a capacity cost of around US\$0.0001 per watt. Comparable solar capacity costs around US\$4 per watt just for the solar panels.

On the thermal side of the game, thermal energy at about 80 percent conversion efficiency is so cheap (about US\$6–10 per million btu) that the energy savings generated by solar thermal capacity will take virtually forever to pay out its first cost. (Don's life cycle costs statement has been noted. Does he or anyone else have any figures that support it across the whole spectrum of residential applications?)

It is mostly wishful thinking to assume that you can substantially replace an enormous, stodgy infrastructure with alternative technologies that have orders of magnitude higher costs than the old technologies they replace. The fact that most 1970s solar hot water companies went out of business when publicly funded incentives ended is confirmation of this fact. The economic burden of a forced changeover would crush most little guys and send them back into the dark ages.

It is my opinion that the high cost of solar capacity and the intermittent availability of solar power will always limit pure solar applications to a very narrow range of usefulness. A more balanced view will recognize this and attempt to find combined technologies that can bring out the maximum benefit from each technology's advantages. My whole thrust for the past forty years has been to find a mix of appropriate technologies that enhances independence, and to evolve a practical role for decentralized (distributed) energy generation in the home and in industry. From 1890s steam engines to the latest fuel cell systems, I have seen them all. There is no question in my mind that careful integration of combustion technologies is a key part of any workable renewable strategy.

I have evolved in my own mind how to best combine combustion technologies with renewables to obtain a renewable/combustion hybrid power plant that will give a homeowner seamless, unattended electrical and thermal energy, cost less than the current assemblies being specified, and produce the smallest possible environmental impact—both locally and globally.

First, all isolated, off-grid power plants must start with an inventory of loads. Conservation and careful planning of loads is the key to economical power plants. There are many off-the-shelf components now available that make load reduction easy while maintaining a "mainstream lifestyle." Don's remarks on efficiency are central to this part of the process.

Second, matching a battery/inverter system to the loads, including overall kilowatt-hours, peak capacity, and surge capacity is the critical "power management" part of the scheme. Undersizing inverters and oversizing battery banks are the common mistakes that result from ignoring this phase of the specification.

Third, determination of the dominant available sources of heat and electricity generation is the final exercise that determines the primary direction of investment in renewable sources, engine generators, propane-fired thermal converters (hot water tanks, boilers, etc.), or all of the above.

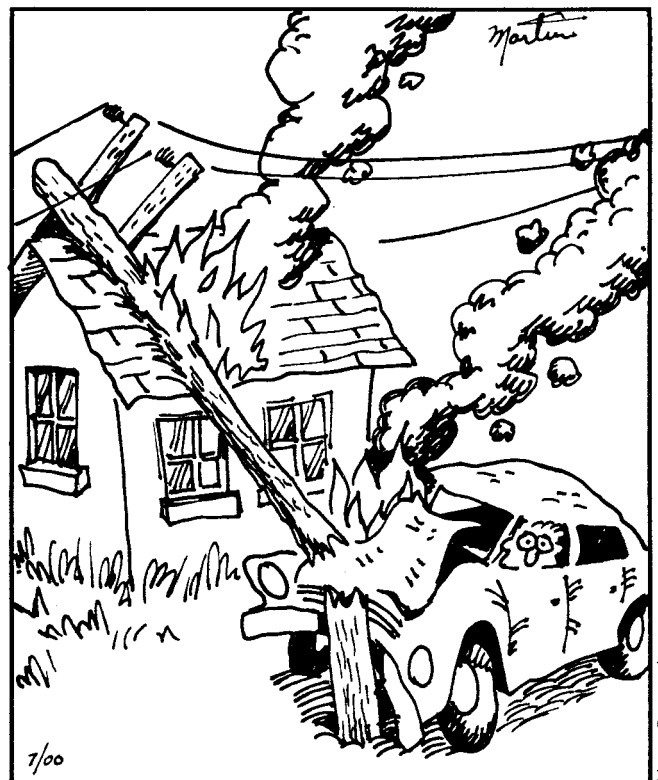
While the above comments may run counter to some of the more extreme renewable viewpoints, taking renewables to the mainstream will require balanced views that include everybody. If this can be accomplished, we all have a better chance to retire all the CO<sub>2</sub>-belching dinosaurs that really do need to go. Thanks for the forum. William L. Petitjean, P.E., President, E-MultiSource, Inc. • petitinc@nwlinc.com

*Thanks, Bill, for a definitive analysis of the CO<sub>2</sub> issue. I agree with your main point that we must focus on the big offenders first. That makes sense, and yes, in the real world we must be aware that economics will shape our choices. I, in a sense, was addressing the issue with a sledge hammer while you went at it with a scalpel. Hyperbole may be of value at times, but if it's my brain being worked on, I vote for the guy with the scalpel. Kind regards, Don Lowebug*

*Hi William, I feel that you are missing certain key issues by focusing on the economic variables in the equation. Your analysis is only true if one considers initial off-grid costs, disregarding fuel, maintenance and sustainability. On-grid, your analysis disregards our environment.*

*The prices we pay for carbon power are artificially low, subsidized like solar in the '70s, and not the real costs of that energy. If we paid these full costs out of pocket, renewables would fare better in the comparison. The utility-scale solar and wind plants I visited recently in California were both producing clean energy at costs equivalent to that of carbon power.*

*My understanding is that the payback time of solar thermal is short enough to make it highly economically feasible, without subsidies, in most parts of the U.S. Ben Root*



Those who live by the grid, die by the grid.





# Tales from the Net Metering Trenches

Richard Perez

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**I**t never ceases to amaze me. After passage of net metering laws in thirty states, America's utilities still don't have a clue about what's going down. In states with net metering laws, utilities are still doing their best to keep our RE off of "their" grid. In states without net metering laws, the situation is far more simple—we just go guerrilla and they hardly know we are there. Not yet, anyway.

## What is Net Metering?

Net metering means that utility customers can sell their excess renewable energy to the local utility at the local retail rate. Most state net metering laws have a provision that limits the amount of RE that the customer can sell to the grid. Most net metering laws state that, on a yearly basis, the customer can sell no more energy to the utility than the customer consumes from the utility. The end result is that a utility customer could have a zero electric bill from their utility. Net metering laws are designed to aid households in reducing their electric bills and the pollution associated with electric power generation.

## A Strategic View of the Battle Front

In every state, the net metering legislation was passed over the objections of the utilities operating in that state. Some net metering laws go back over nineteen years, while others were passed just last year. In every case, utilities have done their best to see that net metering legislation either doesn't pass at all, or that if it does pass, it is ineffective. America's utilities are trying to hold on to their century-long, publicly-granted monopoly of electric power production. After all, electric power is a

very big business—over 230 billion dollars annually in the USA alone.

People who are trying to install net metered RE systems are finding it difficult to impossible. Even in states with net metering laws, we are discovering that utilities are still not cooperating—they are defying the law. In these instances and in states without net metering laws, people are placing their excess RE on the grid without utility permission—guerrilla solar.

The main feature of this battle front is money. The utilities want to hold on to their monopoly, and feel challenged by homeowners placing RE on the grid. Allowing us to become producers of grid electricity sets a precedent that weakens their monopoly. From the homeowners' perspective, money is not the issue. These on-grid RE systems are lucky to break even over a twenty to thirty year period. No one—not with official net metered systems or guerrilla systems—is doing this to make a buck. It's just plain cheaper to buy the government-subsidized utility power.

Folks are doing RE on the grid for three reasons—an uninterruptible supply of electricity, a higher quality supply of electricity, and to help clean up our environment. Saving money or chiseling a few bucks out of a utility is not the motive. RE on-grid is simply more expensive than using grid power exclusively.

## Tales from the Trenches—Connecticut

I recently spoke with a man who attempted to net meter his large (over 3 KW) PV system in the state of Connecticut. His local utility replied that they had yet to formulate their net metering policies and requirements. Connecticut has had a net metering law since 1998, and this utility still hadn't done its homework. They told this customer to call back in six months or so and maybe they'd have the necessary rules and regs ready. Then they could discuss net metering this person's system. This is from a utility in a state that has had a net metering law in place for two years now!

The person said "fine," went out to the power shed, and pushed the sell button on his inverter—he became a solar guerrilla. This guerrilla has a large system, and he was shocked to find his next power bill far higher than it was before he started putting his unauthorized RE on the grid. It turns out that this guerrilla has one of the new remote reading meters. It counts energy moving in either direction as a purchase from the utility. This guerrilla is actually paying the utility retail rate for each KWH of solar electricity he places on the grid. Such is the egotism of utilities that they build electric meters that consider all electric flow, regardless of direction, to be a sale from the utility.

I asked him if he was going to stop putting his RE on the grid because it was costing him money to do it. He replied, "No." He said that the reason he was doing this wasn't related to money, but to our environment. He wasn't concerned that the utility was charging him to share his RE with his neighbors, stating that it was a small price to pay for allowing his neighbors to use his surplus clean power. Such is the spirit of solar guerrillas.

### **Tales from the Trenches—Oregon**

I was recently involved with the installation of a grid intertied PV system in John Day, Oregon (see the editorial on page 8 of this issue). We worked with the local utility, Oregon Trails Electric Coop (OTEC). OTEC originally told us that the metering setup at the Grant County Fairgrounds would not support net metering since it was a three-phase unidirectional configuration. OTEC installed a separate connection into their grid for this system, and to their credit, they did this for free.

About a week before the system was to be installed, OTEC contacted Jennifer Barker, who dreamed up this system. They told her that there would be a \$15 per month fee to read the meters on this new RE system. We hit the roof. Technically, this is not a net metered system since there is absolutely no electric power consumption from the grid. All this system does is put solar electricity onto the grid. We are essentially donating about \$7 worth of electricity to OTEC monthly, and they wanted to charge us \$15 to read the meter showing how much electricity we had donated!

You can bet that we complained loudly. OTEC backed off, saying that it would make this particular system an exception, but that they would charge extra to read the meters of all other net metered systems in their operating area. Oregon's net metering law prohibits extra charges by utilities on net metered RE systems.

Such are the tales from the trenches. First we work for years to get a net metering bill passed. Then we have to fight each utility, system by system, to get this law implemented in their operating area. It's no wonder that folks go guerrilla, or go off-grid entirely.

### **The Positives of Net Metering for Utilities**

I am truly amazed that utilities are fighting RE net metering so hard. Aside from setting a precedent against their monopolistic stranglehold on electricity, there is no real downside for them. Many of the technological advances that utilities crave are embodied in RE net metering.

### **Distributed Generation**

For years utilities have been extolling the benefits of distributed generation. The concept here is that instead of building huge power plants and shipping the energy

for miles over power lines, we can build many small power plants and have the energy consumed more locally. This is a sound concept. It increases grid reliability while decreasing transmission line costs. Net metering does exactly this—it gives us many small generating sources located very near to where the energy is consumed. An added benefit is that solar energy is produced during peak consumption hours.

### **Capital Investment**

Net metered systems are paid for and maintained by homeowners, not by the utility. Here we have the situation where the finest and most expensive form of power is sold to a utility without the utility having to invest one cent of their capital in the generation sources.

### **Green Power to Sell**

If enough net metered systems can be accumulated, the utility can sell this RE to non-net metered customers as "green" energy. Utilities currently consider PV-produced energy to be too expensive—they are not putting up PV power plants, we are. We're installing these PV systems with our own money and offering our surplus solar energy to utilities at less than it costs us to produce it.

Green energy commands a higher price than brown energy because it doesn't damage our environment. For utilities currently offering green power options, consumer demand has far surpassed their ability to generate green power. Net metered RE systems have the potential to fill utility coffers with "green" dollars while not costing them one cent in capital expenditures.

### **Power Reliability**

Net metered RE systems offer greater reliability to the grid. Having thousands of small distributed power generators means that the failure of one large power plant doesn't have a great effect on the grid as a whole. Having thousands of distributed sources means that the energy is consumed close to where it is produced. This lessens the cost, loading, and dependence on expensive long distance power lines.

### **Power Quality**

As the grid becomes more overloaded, power quality suffers. Brownouts, high harmonic distortion, and even blackouts are becoming regular occurrences. Once again, the distributed generating capabilities of net metered RE systems can aid the grid in maintaining its power quality and constancy.

### **The Negatives of Net Metering for Utilities**

I searched long and hard for any legitimate or substantial negative impacts of net metered RE systems to the grid. I can find only one—net metering establishes a precedent that utilities do not have a

monopoly on power production. Under the latest round of utility deregulation, this monopoly is already being challenged, and on a far larger scale than net metering would for many decades to come.

Technology has already changed electricity from a rare commodity produced only in large utility power plants, to something that can be produced on anyone's roof. Like it or not, the days of utilities having a monopoly on electricity production are numbered.

## A Dinosaur Mentality

Utilities have grown fat and slow under their hundred-year monopoly. They have forgotten that the public (that's us—you and me) have granted them this monopoly. They have used their profits to ensure their survival in spite of the environmental damages they cause. I can think of no sadder major industry in the USA than our utilities.

In a recent survey of utility employees conducted by KPMG LLP, a professional services firm, the following interesting facts came to light:

*"Of the 197 utility employees surveyed nationally by KPMG, 78 percent responded that they had observed violations of the law or company standards in the previous 12 months."*

*"46 percent of all utility employees trust their company and its management, which is 13 percent lower than the national average."*

*"56 percent of utility employees feel that their customers would recommend the company to others, a full 14 percentage points lower than the national average."*

This last quote is the most telling since if you don't like the local utility, you can't purchase electricity from a competitor. In almost all states, utilities have a monopoly within their service area.

## What Can We Do?

Go Solar! The clearest and best resource for change in the morass of utility greed and pollution is to stand up and fend for oneself. The installation of a renewable energy system offers you reliable, high quality, clean power. If you have excess RE, put it on the grid, authorized or not. Share the benefits of clean energy with your neighbors.

## Access

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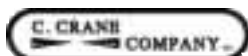


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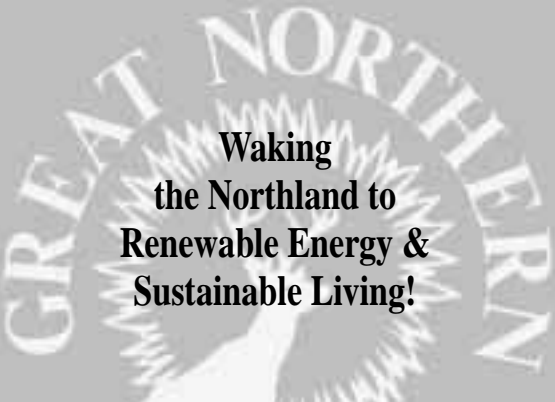
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## **Adopt a Library!**

When Karen and I were living with kerosene lamps, we went to our local public library to find out if there was a better way to light up our nights. We found nothing about small scale renewable energy.

One of the first things we did when we started publishing this magazine twelve years ago was to give a subscription to our local public library.

You may want to do the same for your local public library. We'll split the cost (50/50) of the sub with you if you do. You pay \$11.25 and Home Power will pay the rest. If your public library is outside of the USA, then we'll split the sub to your location so call for rates.

Please check with your public library before sending them a sub. Some rural libraries may not have space, so check with your librarian before adopting your local public library. Sorry, but libraries which restrict access are not eligible for this Adopt a Library deal—the library must give free public access. — Richard Perez

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# Q&A

## Aluminium Wire

Just received *HP78*—another stellar performance by the crew at Funky Mtn. Institute! Maybe I should get a life, but not much brightens my day more than receiving the latest issue of *Home Power*. It's been fun watching the system transitions at *HP Central* over the years, and using your upgrades as a guide.

Booster battery—now there's a concept! (After reading the latest *Home Power*, Al, bowing and scraping, approaches his wife. "Susan, honey, dear, can't we free up a few bucks for just one more tiny improvement to our system? Oh, I know last month was the new RV Power Products charge controller, but we really need a couple more batteries to make a booster battery. Oh, yes, it will definitely improve our quality of life by leaps and bounds, and I'll never ask for another component, at least not until the next *Home Power* comes out...")

In the past, *HP* articles have recommended copper wire for all runs. Recently I've noticed the use of aluminum (aluminium to some) wire for long runs. What a relief! Several years ago, I moved my panels and batteries out of the house to an outbuilding 100 feet away. Daunted by the cost of copper wire for that 100 foot run, I looked into aluminum. It worked out that #2/0 aluminum would be adequate, much cheaper than a size smaller copper.

Then to my surprise, I found that 100 feet of URD aluminum cable (two #4/0 wires and one #2/0 wire wrapped together) was cheaper than 200 feet of #2/0 AL alone—some weird economy of scale thing. So I used the two #4/0 cables to make the run (separated the #2/0 out and am still trying to find a use for it!).

So, it seems that an article on the proper sizing, connections (and maintenance of those connections), and use of aluminum wire is in order and would be of interest to your readers. I understand that there are some rules of thumb for making connections with AL wire, especially making the transition from AL to CU. I hope I did it right... Before you say "Good idea, why don't you write it, Al"... Even though I've used AL cable, it doesn't mean I really know anything about it, and I'm sure there are many nuances and techniques unknown to me.

Your comments about air travel were interesting. I'm old enough to remember when air travel was fun! It sure isn't anymore. Nothing like being stranded in an airport

for hours or days with kids—it would almost be easier to spend days with them in a car... I'm certainly looking forward to the time when they move transporter technology out of *Star Trek* and into our world. Anyway, keep up the great work—we all appreciate it more than we let on. Al Latham • [thinkedg@olypen.com](mailto:thinkedg@olypen.com)

*Hello Al, We used aluminium wire on some 117 VAC circuits, and we have also used it on a 50 volt DC wind generator power line, and on some high current, 24 VDC PV power lines (from array to power room).*

*The reason we do this is cost. For the same resistance, aluminium cable is less than 1/3 the cost of copper. There are indeed some tricks to using aluminium cable. Here's what we've learned:*

- 1. Don't make connections on aluminium where it will be out in the weather. All the connections should be made inside a building, or inside a weatherproof box.*
- 2. Polish the wire strands even if the cable is brand new. We use a Makita drill and a small wire wheel to do this.*
- 3. Liberally butter the polished bare wire strands, and the connector, with an oxide-resisting compound such as NoOx.*
- 4. Only use connectors rated for copper and aluminium mating.*
- 5. Tighten the hell out of the connections, and tape or shrink tube them well.*
- 6. Since aluminium wire has higher resistance than copper, aluminium wire should be oversized by two AWG sizes compared to copper.*

*Aluminium oxidizes rapidly when exposed to moisture. It's essential that mechanical connections be bright, tight, and sealed against oxidation.*

*As far as the extra #2/0 conductor, you could use it for a smaller (less current) or shorter run. Or it could easily be paralleled in with either the negative or positive of the main run (I prefer negative because in some systems the negative current handling conductor is grounded, but it really makes no difference). This in effect gives you a 250 MCM wire gauge. But since #4/0 is pretty big already, I suspect you don't need even lower resistance.*

*Tell Susan I'm sorry to aid in continually picking your pockets. An RE system is almost organic and always seems to grow and change. Look on the very bright side—what are you going to be able to do with all that new electric power? Richard Perez*

## Homemade Battery Connectors

I just wanted to thank you for an article you wrote long ago on making your own battery connectors. I had

taken the easy way out and bought ready-made connectors. They seemed very flimsy when out of the package and were no better when soldered. I remembered reading your method on the CD I had purchased some time ago. I redid the connectors using soft tubing as you suggested. The first one was the worst of the lot, but still usable. They took a while to make, but were well worth the effort. I suppose the lesson is twofold:

1. No easy way out
2. Read *Home Power*

Also for something constructive to do at our camp at night, I will be putting together the battery desulfator project from the *Home Power* Web site, using one of the best little gifts my wife ever gave me, one of those soldering irons that run on butane. The project parts I ordered off the net arrived while I was at the camp installing two Kyocera 80 watt panels. Thanks again, Peter Millington • [sinistr@ns.sympatico.ca](mailto:sinistr@ns.sympatico.ca)

*Hello Peter. Those handmade battery/inverter connectors are bulletproof. They are the only connector I know of that has less resistance than the cable to which they are soldered. Their mechanical strength is sufficient that you can pick up a very heavy battery with them (but we don't recommend that because most battery cases are not designed to allow lifting by the posts). The original article appeared in HP7, page 36. Although that issue is out of print, the whole issue is on our Solar2 CD-ROM. We are still using handmade cables here. Some are over 25 years old and have outlived four different batteries. Thanks for the flowers!*  
Richard Perez

### Battery Questions

Hello Richard, I hope you can enlighten me with answers to a couple of questions I have regarding batteries.

1. I have often heard it said that lead-acid batteries like to "grow up" together—that keeping them matched up is proper. I believe that adding a new battery to a group after 15 percent of their lifespan is over is not good, and that the new battery will only charge up to the level of the weakest battery/cell in the group. I'm looking for an explanation of how and why this is so. Do you have a simple symbolic/practical example as well as a scientific one that basic learners can comprehend?
2. I have a 24 V 2.2 amp charger for a small electric scooter and a 24 V 12 AH battery. According to my calculations, the charger puts out 52.8 watts, and it will take approximately 5.5 hours to bring the battery up to 100 percent charge, totaling 288 watt-hours. If I pay 10 cents per KWH, does it in fact cost 2 cents to charge up

the battery at that rate? Of course all things being equal, there is power lost through resistance and charger inefficiency as well. Thanks for your assistance!  
Ben Macri • [benmacri@home.com](mailto:benmacri@home.com)

*Hello Ben. Yes, what you have heard is roughly correct. If you maintain your batteries properly, and completely recharge them routinely, you can add new batteries to the battery pack for about two years. If the batteries are abused by not recharging them fully or by not doing equalization charges, this period will be much shorter—on the order of a year or less.*

*One analogy is an iron chain exposed to salt water. As the links rust, their ability to handle a load decreases. If a single link fails, we might replace it, but the entire chain will not be as strong as it was when it was new—it will be limited by the strength of the weakest rusty link.*

*It would take someone who knows more about electrochemistry than I do to tell you the specific electrochemical mechanisms that cause aging and eventual failure in lead-acid cells.*

*I would double that cost figure on that scooter charge to about 4 cents. Most battery chargers are between 50 and 70 percent efficient, so you are actually having to put almost double the energy into the charger as you are getting out of it. Also, the battery itself is not 100 percent efficient, but more like 80 to 85 percent efficient, and possibly lower than that if the battery is being deep cycled, as would be the case with your scooter. I would expect that charger, if it actually puts out 2.2 amps constantly, to require about 6.5 hours to totally recharge that battery if it was fully depleted. Overall it's probably costing you a nickel to recharge that scooter.*  
Richard Perez

### What Does It Cost?

Hello, I have enjoyed your site on the Net for some time, and enjoy your articles. My wife and I have been considering building an RE home. I have been trying to educate myself as to what is needed. How much is enough and what is too much? That has been a tough question to answer, to say the least, and I get a real headache after a while.

We would like to install a hybrid system when we build. We live in southeastern Idaho, near Idaho Falls. I understand interest rates are going up after the first of the year (who knows for sure?) and would like to get financing locked in before then. We presently own a home and need to get it sold. The last article by the Bells was great, but the price of their system was more than I spent to buy my present home!

I do understand that you need to spend some money for quality items, but that is way out of my price range. We feel good about building an RE home. There is so much that you can't have an impact on these days. I feel that if RE was put into large-scale practice, this country and world would be much better off. But my income tends to say how much I can do... Thanks,  
Norm & Brenda Tew, Shelley, Idaho  
spdprus@mail.ida.net

*Hello Norm and Brenda. The cost of an RE system is entirely dependant on how much electricity you need. Steve Bell's system is cycling over 25 kilowatt-hours per day—that's a lot of electricity! I know of homes that consume between 2 and 4 kilowatt-hours per day, and the folks have all they need—refrigerator, computer, lights, TV, VCR, washing machine, microwave oven, toaster, well pump, and other appliances. These systems cost between US\$6,000 and \$12,000 if they are PV based, and far less than that if you have wind power or microhydro power resources available.*

*If you don't need some of the appliances listed above, or if you can conserve in other ways, the cost will be lower still. The point is that you determine how much the system costs by your electric power consumption. Less consumption means fewer system components and a lower price tag. I know of cabin systems that cost less than US\$2,000, and supply enough power for lights and communication electronics (TV/VCR, radio, stereo).*

*The key to an inexpensive system is conservation. Examine what you really need electricity for; then buy the most efficient appliances and use them wisely. Every dollar you spend on efficient appliances will save you three dollars in system components.*

*The best way to begin is to analyze your electric power needs. There is information and software to aid you in this posted on Home Power's Web site at [www.homepower.com](http://www.homepower.com). Be ruthless with your appliances and eliminate energy wastrels such as incandescent lamps and phantom loads. I think you will find that if you are realistic with your energy habits, you will be able to afford a system that will meet your needs. Richard Perez*

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**VERMONT PV DEALER.** David Palumbo/Independent Power & Light has been installing off-grid systems, and helping do-it-yourselfers (who buy their equipment from him) with free professional design advice for over 10 yrs. Trojan and Surrrette batteries. FREE with battery purchase IP&L deep cycle battery instructions. Trace, Solarex, Siemens, and BP at fair prices. Large supply of wire and cable. Beware of "fast buck artist," slick talking, "lowest price anywhere" mail order companies who don't take the time to find out what you really need and can't spend the time on personal support and service. Buy from an honest dealer who knows the products and cares about your success in using them. David's installations are innovative, simple to live with, and successful. And our long following of do-it-yourself customers always come back for more because they can rely on getting straight talk, no BS, and the best service possible. "David is one of the original RE pioneers... he knows how to really squeeze all the energy out of a KWH!" Richard Perez (*HP60*). I P & L, 462 Solar Way Drive, Hyde Park, Vermont 05655. Call David Palumbo 802-888-7194. Email: [indeppower@aol.com](mailto:indeppower@aol.com). Web site: [INDEPENDENT-POWER.COM](http://INDEPENDENT-POWER.COM). No catalog requests please. Please call for appointment before visiting.

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