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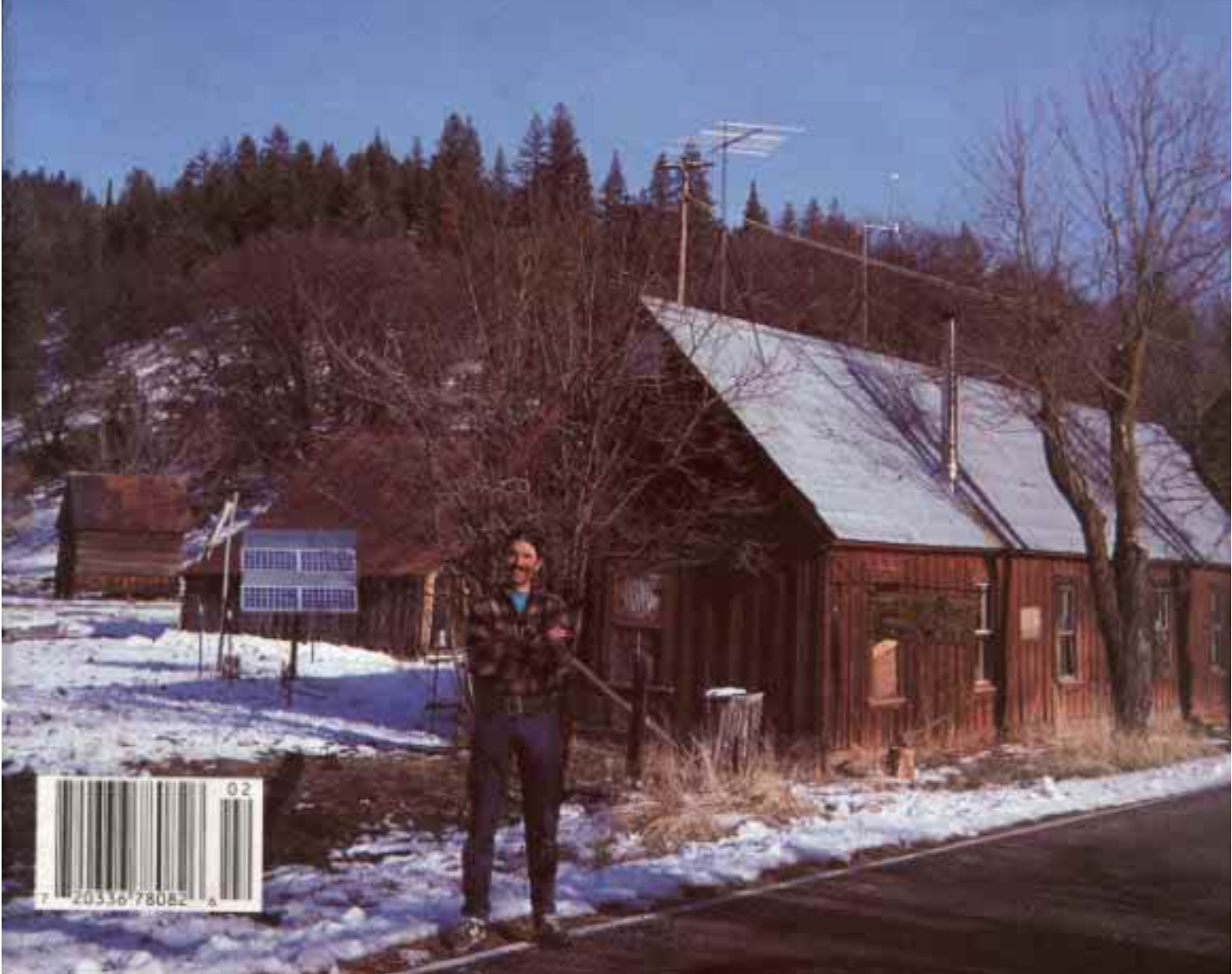
# HOME POWER

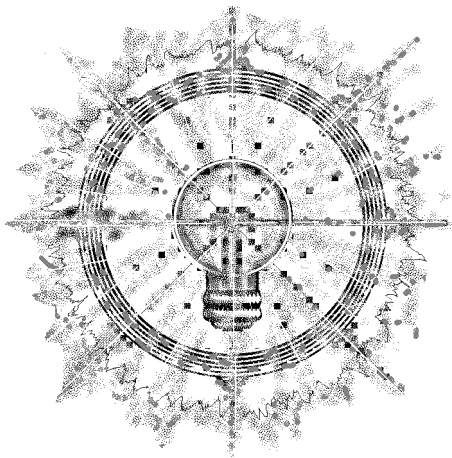
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# HOME POWER

## THE HANDS-ON JOURNAL OF HOME-MADE POWER

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### Think About It

"Man masters nature not by force  
but by understanding."  
Jacob Bronowski

### Cover

Old hippies don't die, they just put  
up PV panels and run  
solar-powered businesses. See  
story on page 6.

Photo by Don Clark.

# PV Dreams

Bill Battagin

©1993 Bill Battagin

I still remember. We were headed to the Sierras to camp; I was 9 years old, gazing up through the rear window of my family's Pontiac station wagon at the clouds. Big white, puffy, cottonball clouds. I dreamed of flying around, through, and under those beautiful, soft, and inviting masses of water vapor and ice crystals. A child's dream turned into reality when I began hang gliding. It took me another 7 years of flying, but I made it up to those puffy cumulus clouds where I physically and spiritually played like never before.

I fulfilled another major dream in my life when, in 1982, I bought a photovoltaic (PV) panel and powered a few small loads in my grid powered house. The bug bit and it bit good. I saw the beauty of what that one panel did for this planet, our biosphere, and my spirit more and more. I bought a couple more panels, a small inverter, and more batteries. Then I made the leap in 1988 and bought eight ARCO M55 PV panels. I disconnected all the loads in my house from the grid, and made the switch to a stand-alone PV system. I was again in those spiritual clouds, playing like I've never played before.

## Work can be fun, too

I have yet to see any signposts along my path that say, "Stop Dreaming" or worse yet, "Go Right." Last year I installed a starter system at my grid-powered business. Though I knew this 4 panel, 600 watt inverter system would never cover all my needs, the seeds would be planted. A good chunk of what I do to keep myself off the streets is build catalytic woodstoves. People had been telling me for years that I couldn't weld with a solar electric system, not for less than a million dollars, anyway. (Of course, people can't fly either).

## SEER-ing Experiences

Unable to accept being "grounded" by this limitation, I searched for a workable welding system. I bumped into Bruce Colley of Glenn Products at SEER '91 (the Solar Energy Exposition & Rally in Willits, California). He invited me to "run a bead" with his battery-powered wire feeder. Welding with this system — which could easily be powered by the sun — was electrifying! Within a year, Bruce sent me one of his MIG units, adapted somewhat for a "production-type" welding environment instead of the portable, short-job type welding for which the unit had been conceived. I should mention that this welder, being a modified unit, is not yet in production at Glenn Products. Bruce is very concerned about completing all aspects of the R&D on this version of his original machine before it becomes available to the public.

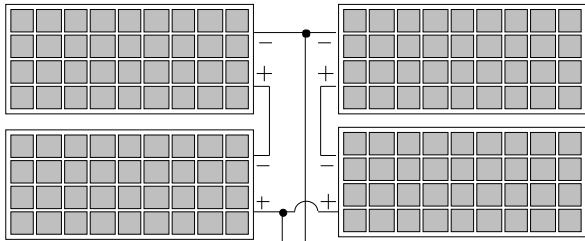
At the time, my system at the shop consisted of four Kyocera 51 Watt photovoltaic panels, and a Heart 600 watt inverter to invert the DC electricity to ac. For storage, I selected the best eight batteries out of the deep cycle pack in my electric van. My guess is that these batteries still have about half to a third of their "chung" left to them — "chung," you know, umph!! There are 880 Amp-hours at 12 Volts storage.

This new welder needed 24 Volts DC to operate, so some reconfiguration was necessary. I swapped some wires around in the battery box to satisfy the welder's needs — no biggie. I shelled out about a hundred bucks for a controller, but I did not want to spend another wad on a 24 Volt inverter for my 117 volt ac loads. Fortunately, while attending SEER '92, I found Dave Katz of Alternative Energy Engineering fame. He was drooling on all the new inverters at the Fair, wanting one but owning a perfectly good 8 year old, 2000 watt Trace 2024 inverter. I should talk, I was in his booth drooling on a used Trace 724. When all the drooling was over, I got Dave's 2024, and Dave had the down payment for his new electric dream box.

## Today's System

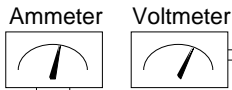
So, with the same storage, and PVs still at about 200 Watts peak power, I connected the 2024, and Bruce's welder to the batteries. I couldn't help it — I didn't really expect it to happen again — but there was that floaty feeling. It's like eating a real homegrown tomato instead of one of them red things from the store...*flavor!!!* I can see a little "sun" at the tip of the MIG gun melting, filling, and joining steel. It's so direct, simple, and clean compared to the huge infrastructure necessary to make electricity for the grid.

4 Kyocera 51 Watt Photovoltaic panels wired for 24 Volts

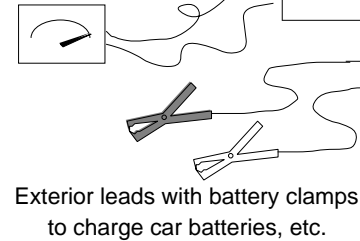


#4 gauge copper wire

10 Ampere  
Heinemann DC  
Circuit Breaker



Fun meter

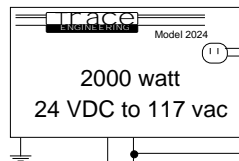


Trace C30 A  
charge controller

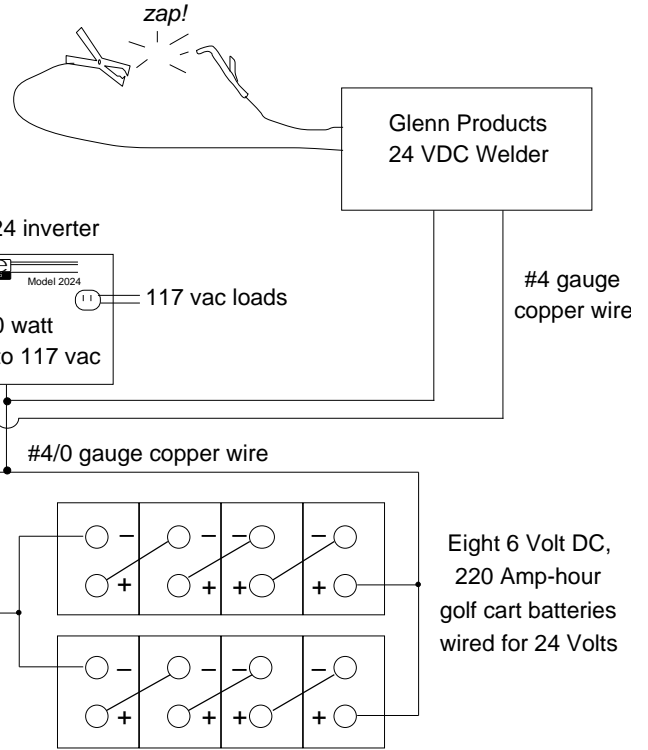


20 Amp  
Double Pole Double Throw  
Switch

Trace 2024 inverter



**Bill's Shop System:  
Feather River Stove Works**



**Ac Wiring**

My woodstove shop had been powered by the utility grid only, so to wire for ac from the inverter, I just installed "solar" ac outlets next to the grid outlets. This system offers two distinct advantages: If I'm low on power, I don't need to spend more money on a standby/charger option, just move the plug over to the grid outlet. Secondly, I can individually choose which tools I want to power with the inverter, instead of dedicating a whole circuit to one or the other power source. It was easy for me to do this additional ac wiring.

I did pretty much the same thing with the lights. I have two sets: one grid-powered, one solar-powered. The lights that are solar powered are Phillips SL18/R40 compact fluorescents with reflectors which are very efficient in a shop type environment. The utility grid will be in the back-up role in another year or two when I can afford to size my system to supply most of my shop needs.

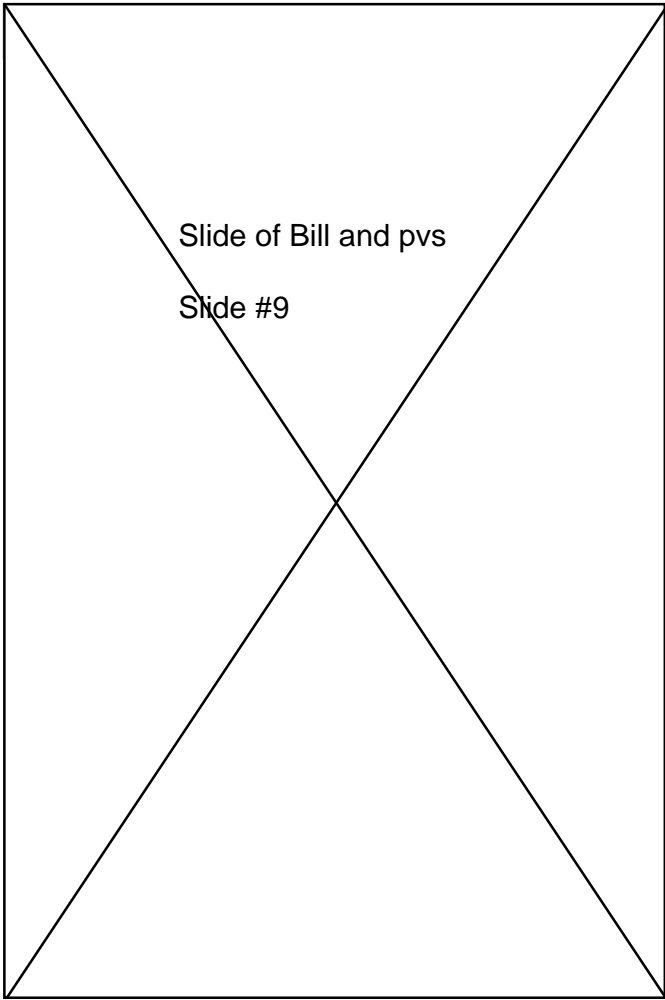
Here's a list of the larger tools and machines the Trace 2024 inverter can run:

- Milwaukee 2.25 hp, 13 amp anglehead grinder, #6082
- Milwaukee 15 amp, 14" cutoff saw, #6170

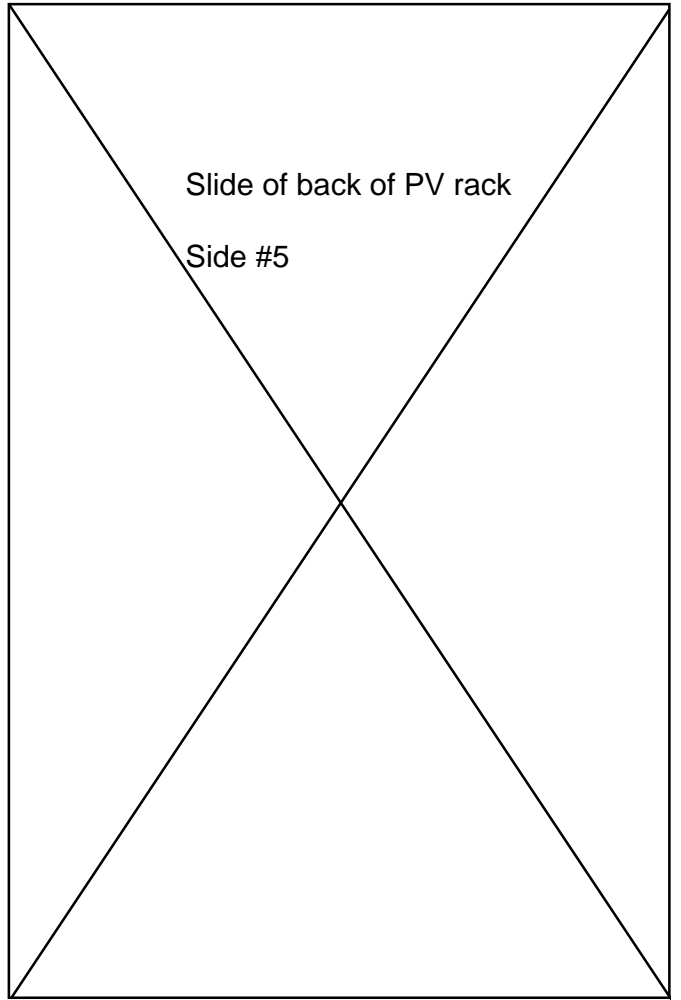
- Delta 3/4 hp, 12 speed, drill press, #17-900
- Craftsman 1 hp 6.8 amp, 8" bench grinder, #257.191601
- Craftsman 1 hp, 15 amp compressor, #919.154010
- Milwaukee 8 amp Shop vac, #8935
- Milwaukee 3 hp, 15 amp anglehead grinder, #6098

Any one of these appliances can be run with the "base load" for a period of time which would run my endurance out before the inverter. The base load of lights, stereo, and exhaust fans is about 500 watts. The only load that sometimes overloads the Trace is the compressor during start-up. The 3 hp Milwaukee anglehead grinder has "controlled start" which the 2024 has a tough time starting, though it runs fine. Fortunately (for the inverter), a person can only operate one major tool at a time, so a one-person shop can be run by a moderately sized inverter. I'm not sure what's to blame, but I have fried an induction type motor in a window fan. Also, the starter in the larger Milwaukee anglehead grinder is acting weirder all the time. These could be attributed to age — I wonder about the inverter, though.

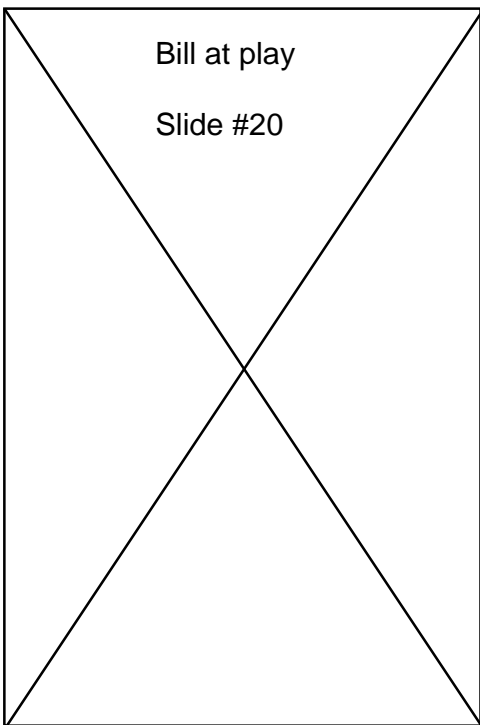
If it's sunny, I can work two "average" days before the battery voltage gets to a point (about 24.0 V) that I feel



Above: Bill relaxes by his PVs in beautiful Genesee Valley.



Above: Tracking the sun by hand — details of the homemade PV rack.

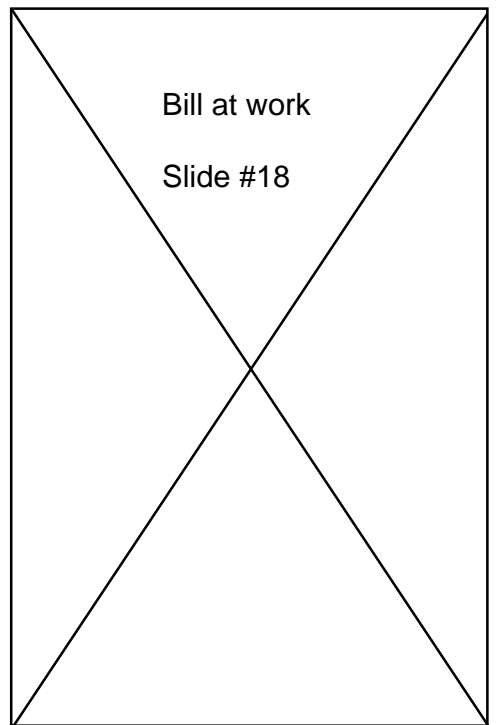
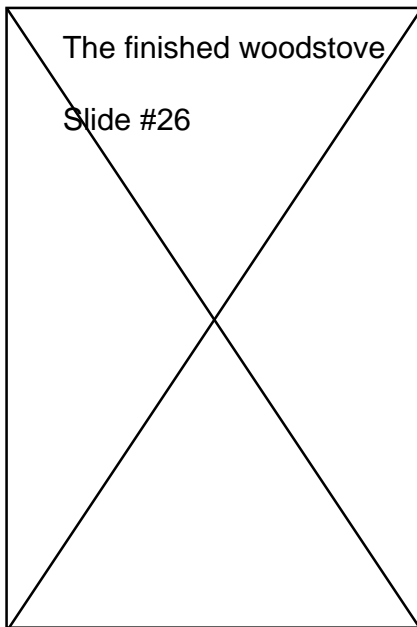


Below left: Bill uses his grinder on all sorts of things!

Below center: The finished product.

Below right: Bill hard at work.

Photos by Don Clark



the need to use more grid power. If I'm using the welder or the compressor a lot, it might be one day on solar power. Fortunately (for the stovebuilder), I usually put in three days or less at a time in the shop. I enjoy working in the shop because I don't *just* work in the shop. Non-shop days are in-the-field installation days.

As much as possible, I drive my electric van to jobs within its range. The van is an Eltravan 600, made in Austin Texas by Jet Industries in the early 1980s. I've had the van for about 4 years. The battery pack consists of seventeen 6 Volt, 220 Amp-hour golf cart batteries (102 Volt system). Power is managed through a Curtis PMC controller and sent to a 20 hp series-wound General Electric motor. The motor then powers a conventional 4 speed gearbox/transaxle to the rear wheels. I can see now we've got a future article brewin'!

### Tracking by hand!

Other noteworthy items are the home-built manual tracker and reflectors. The frame to which the panels are bolted is bolted to a pivot which is welded to a 3 1/2 inch diameter piece of steel pipe (see diagram). All steel parts are coated with cold galvanizing spray. Seasonal tilt is achieved by loosening the 3/4 inch nut and pivoting the rack of PVs at that axis. I change the tilt of the panels four times a year to follow the seasonal angle of the sun.

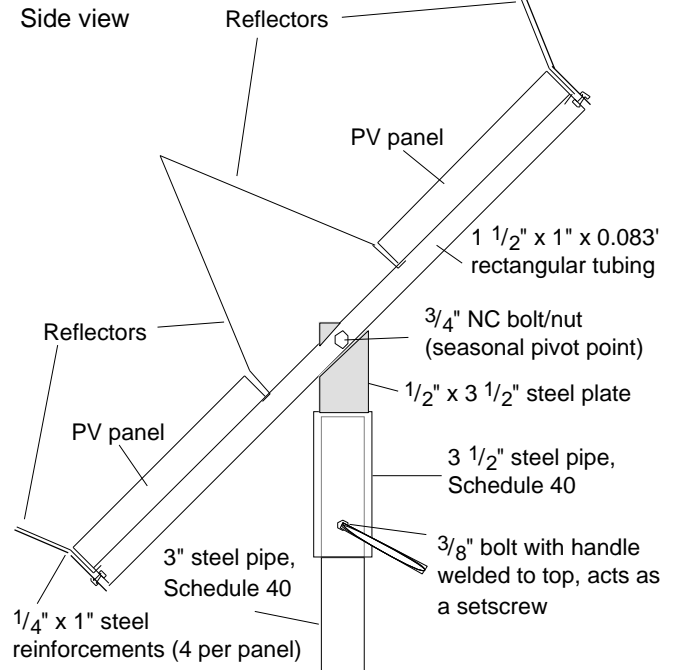
The 3 1/2 inch pipe fits over a 3 inch diameter length of pipe stuck in a concrete-filled hole in the ground. The ends of both pipes have steel caps and are lubricated with grease. In a simple way, this arrangement makes the array easily manually trackable. I take a break from work every one and a half to two and a half hours and spend about ten seconds turning the array. I only turn the PV frame on the pipe. The tilt stays the same, so it is perpendicular to the sun's rays only at noon. Though less than perfect, I got a lot of extra PV output for about \$15 of materials.

### Reflectors

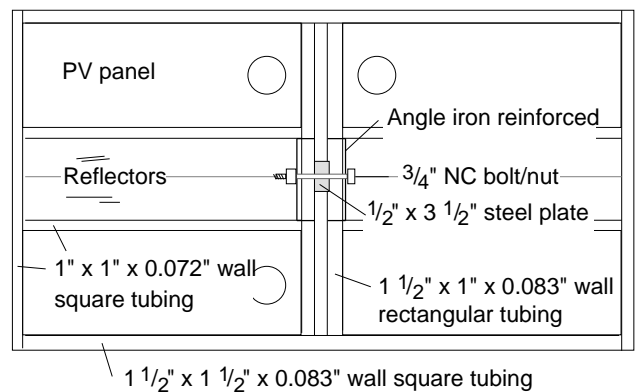
Reflectors are used to increase the amount of them squirrely little photons being directed at the panels. I'm not sure reflecting is the greatest thing since firm tofu, but I wanted to give it a shot. These reflectors are made out of 22 gauge galvanized sheet metal, cost me \$45, and increased my output by 1.0 Amp at 24 Volts. To gain an amp at 24 Volts using more PVs would have cost about \$210. Time will tell the effects of the higher cell temps and ultraviolet exposure on panel life. I know that galvanized steel is a very crude reflector material, but it is low tech, easily found and fabricated, and economically far cheaper than more PVs.

## Manual Tracker and Mounts for PVs

Side view



Back View



I chose to use reflectors for a few reasons. Ambient air temperatures at my 3700 foot elevation here in the Northern Sierras are far lower than those found on the Carrizo Desert. Also, my reflectors do not raise panel temperatures as much as commercially available ones would. Another factor is that the times when it is hot around these parts, my power needs are the lowest; my tracking system allows a very easy way to turn the array out of direct sun. And dang it, I just wanted to try it!!

### What Are We Doing Here?

There is one more thing noteworthy about the system: Economics. I did not install this system (or the one at the house) because the economics were practical or because

## System

### **Cost of the power system for Bill's shop**

Equipment	cost	%
4 Kyocera 51 Watt PV panels	\$1,200	50.7%
Trace 2024 inverter (used)	\$550	23.3%
8 220 A-hr 6 V deep cycle battery cells*	\$160	6.8%
Romex, outlets, fixtures, junction boxes	\$150	6.3%
wire, meters, battery box etc	\$130	5.5%
Trace C-30A charge controller	\$95	4.0%
PV panel support & reflectors	\$80	3.4%

\*Represents used battery prices

\$2,365

it was cheaper than doing something else. My motivation for using photovoltaics in my life is to walk lighter on my path and to take less along the way. I could afford them, so I did afford them. For a look at the financial part of this picture, see chart above. Onward!

#### **Back to work**

I'm an addict. I simply cannot get enough PVs to satisfy my habit — dreaming. If I could afford it, I'd give samples to all the kids in school to get them hooked too. So I must

go back to work to make more money to buy more panels. My guess at this point is that another 4 panels and increasing my battery storage by about 50% would get me close to 100% solar at the shop. Though I pulled the eight best batteries from the van, they are still four and a half years old and were not treated kindly. The increase in storage capacity would be achieved with 12 new batteries (660 Amp-hrs at 24 Volts). When the shop system is finished, then there's the store where I *sell* my stoves....

What an incredible blessing, loving the work I do. The stoves are keeping folks warm while cooking their food and heating the domestic water. The grid meter spins less and less; the fun meter spins more and more. Living in Genesee Valley. Kinda like a dream. Thank-you!

#### **Access**

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24 Volts DC Welder: Bruce Colley, c/o Glenn Products, 47 Lafayette Cir., Unit 306, Lafayette, CA 94549 • 510-686-1788



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