

# Troubleshooting

**Richard Perez**

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Let's face it, things break. They fail, they malfunction, and they quit working. If you installed your own renewable energy system, the person who needs to troubleshoot and fix whatever breaks is you. Here are some observations about finding out what went wrong—troubleshooting.

Troubleshooting is more of an art than a science. It is a process of identifying exactly which component or components in a device failed. While the techniques used to troubleshoot electrical equipment are different than those used to troubleshoot mechanical gear, the process is the same—identifying what went wrong and is causing the malfunction.

## *Troubleshooting Heritage*

I began learning how to troubleshoot in my early teens. My father, a career Air Force officer, was director of maintenance for the Strategic Air Command's 100th Bomb Wing at Pease AFB in Portsmouth, New Hampshire. To say that he was into troubleshooting and maintenance would be a huge understatement. He had established a well-equipped home shop in our basement and encouraged me to use it to build and fix things. By the time I was old enough to have a driver's license, I was doing all the troubleshooting and maintenance on our vehicles and home appliances. I learned how to troubleshoot from an expert—my father. This skill served me very well in later life.

In the early 1980s and before getting into publishing *Home Power*, I spent three years operating and maintaining a 100 KW television transmitter for the local CBS TV station. This ancient beast was made by General Electric in 1953, and contained more than 600 vacuum tubes. It was always breaking, and it was my job to find out what was wrong and fix it. This antiquated TV transmitter honed the troubleshooting skills my father had taught me to a razor's edge.

Since then, I have been applying these troubleshooting skills to our home power system. While the PV/wind system we have lived with for decades is very reliable, things still do occasionally break. And when they break, it's a long way to town for either parts or expert advice. So I've learned to do what most home-powered folks do—fix it myself.

## *Attitude*

Troubleshooting is a mental activity, and begins long before applying a wrench to the piece of equipment. It is largely a matter of attitude—you are either your own best friend or your own worst enemy. Here is a list of positive mental attitudes that can make you an effective troubleshooter, and a list of negative mental attitudes that will render you utterly dependent on outside help.

### **Positive Attitudes:**

- Assuming nothing
- Thoroughness
- Patience
- Self-confidence

### **Negative Attitudes:**

- Making assumptions
- Skipping steps
- Impatience
- Self-doubt

## *Mechanical Example*

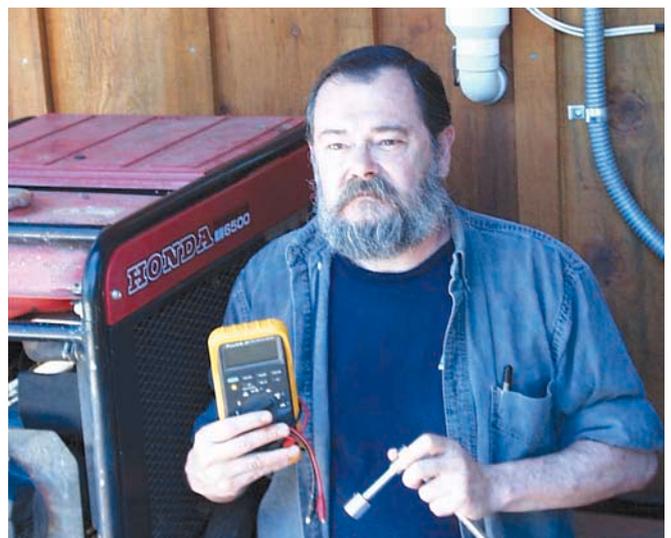
Perhaps the best way to illustrate these attitudes in practice is to tell you about my latest troubleshooting experience. While this experience concerns a mechanical device, not an electrical one, the art of troubleshooting is the same.

Two weeks ago, our back-up engine generator wouldn't start. This Honda ES6500 is about eight years old and has only 1,280 hours on it. It has needed repairs in the past, requiring two trips to the Honda shop downtown. Once was for a leaky rear main engine oil seal that had dried out due to disuse, and the second was for an oil pump replacement.

The dried out oil seal taught me to start the generator at least once a month to prevent the seals from failing. And so, even though it was July and the sun was providing more than enough electricity for us, I tried to start the generator.

When I turned on the engine's electric starter, all that happened was that the engine turned partly over once, followed by a clicking sound. What was wrong? I immediately thought that the engine starting battery was dead. A quick check with a digital voltmeter showed that while the battery was low in voltage (12.22 VDC under no load), it was far from dead.

**Richard, ready to shoot trouble.**



To check the battery's voltage, I had to remove the rubber protective cap over the battery's positive pole. There I discovered that the positive terminal had been corroded by acid schmaze (my word for a smeared haze of acid), and was not making good contact with the positive cable.

After cleaning the positive terminal and the cable's connector, I tried to start the engine again. All that resulted was a clicking sound and the engine wouldn't turn over at all. I connected the engine starting battery to the huge battery in our 12 VDC PV system and allowed it to be fully recharged. Then I went into the house for a cup of coffee and some hard reflection.

I was in the grip of the most common negative troubleshooting attitude. Often when a device fails, it is assumed that the least understood, most difficult to fix, and most expensive part of the device is the problem. I thought that the engine had a major mechanical problem, that it had dropped a connecting rod or valve, and that it was hard frozen. I had succumbed to self-doubt and jumped to a paranoid conclusion—that the part I understood the least and couldn't fix was the problem.

As the coffee cleared my brain, I reminded myself of the troubleshooting lessons my father had taught me. I chided myself for skipping steps—this time by assuming that something (anything, any component) is working properly, so it's unnecessary to check it. I reminded myself that most failures are caused by simple, obvious things. I realized that I hadn't really thought the problem through, that I had assumed the worst. I gathered up my self-confidence and returned to the generator.

This particular generator has a common main shaft for the engine and the alternator. I removed the cover plate from the back of the alternator and gained access to a huge nut at the end of the main shaft. Holding my breath, I put a socket wrench on the main shaft and tried to turn it. It rotated, and with immense relief flooding me, I realized that the main shaft wasn't frozen, and that the engine probably had no major problems.

All that had happened was that the starter's dogs had jammed on the flywheel. Normally, the rotation of the starter would be able to overcome the friction of the dogs on the flywheel. But the low battery voltage caused by the bad positive cable connection wouldn't spin the starter with enough strength. I figured I was home free and patted myself on the back—I'd get this generator started yet.

As I was getting ready to give it another try, I noticed that fuel was dripping from the carburetor—bad sign. I was mystified. What had this fuel leak to do with the bad battery connection and stuck starter dogs? I turned off the fuel petcock and allowed the spilled fuel to evaporate before even considering starting the engine. I returned to the house for another cup of coffee and more reflection.

### *A Combination of Problems*

As I sipped more caffeine, I reminded myself that when equipment fails, it is often a "combination of ingredients" problem. Sometimes the failure of one component will cause another to also fail, and sometimes a piece of gear will have

two or more unrelated problems. I decided that the carburetor leakage problem was unrelated to the starting problem, and returned to the generator to examine the carburetor.

I noticed that the carburetor had two small-diameter, rubber venting tubes attached to it. These tubes were about a foot long and ran from the carburetor to the bottom of the generator where they vented, open-ended, to the outside air. I wondered if the carb was leaking due to interior pressure build-up, and decided to examine these tubes. I discovered that mud dauber wasps had built a cozy home for their larvae in each of the tubes.

A quick run-through of both tubes with a short piece of stiff wire cleared the larvae and their mud packing. I turned on the fuel petcock and was gratified to see that fuel was no longer leaking from the carburetor. I was now ready to try to start the generator.

I hit the starter switch and held my breath. The freed starter dogs engaged the flywheel and the engine turned over. It immediately roared to life and I whispered a prayer of thanks to my father's ghost.

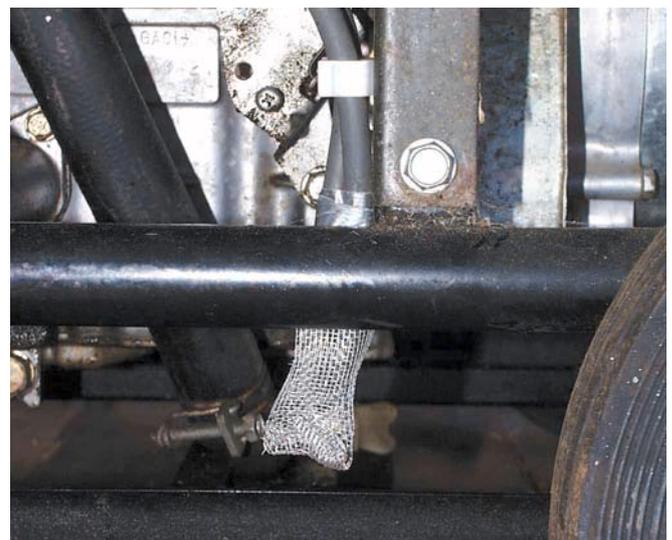
By applying his lessons in troubleshooting, I had avoided having to manhandle the 350-plus pound generator into the truck, spending two hours hauling it to town, and paying for the Honda mechanic to fix what was, after all, a simple combination of problems.

### *Shoot the Trouble*

The art of troubleshooting is not difficult. It just demands a good attitude and observance to procedure. Assume nothing. Check the obvious things first and skip none of them. In my experience, fully 80 percent of the problems, especially in electrical gear, are simple-to-fix things such as mechanical connections.

Give the problem device a good and thorough visual inspection. Better than half of the problems that I have found and fixed revealed themselves upon close visual inspection. Have confidence in yourself—you can find the

**A screen deters mud dauber wasps.**



problem with patient and thorough investigation. Don't succumb to the paranoid fear that the problem is something that you don't understand and can't fix. Give it a try. If you don't succeed, you can always have an expert fix it.

Troubleshooting is made far easier if you are familiar with your equipment. Don't be a hands-off user! Regularly observe your gear and how it's working. The more familiar you are with how things normally work, the better you will be able to recognize what is wrong when things go wrong. Familiarity with your system will enable you to notice when devices are beginning to operate poorly and catch problems before they become outright, and possibly expensive, failures.

Finally, do your maintenance. Maintaining equipment not only keeps it running well, but it gives you the experience and confidence to troubleshoot that gear when it breaks. Let your troubleshooting experience add to your scheduled maintenance. For example, I will now keep a closer eye on the terminals of the engine's starting battery and keep them free of corrosion. And the venting tubes on that engine's carburetor are now swathed in a bulb of fine metal screen—mud dauber wasps will have to look elsewhere for a home for their larvae.

Installing an RE system and making your own electricity is an exercise in independence and self-reliance. Doing your own troubleshooting and maintenance makes you even more independent and self-reliant. Give it a shot!

## Access

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