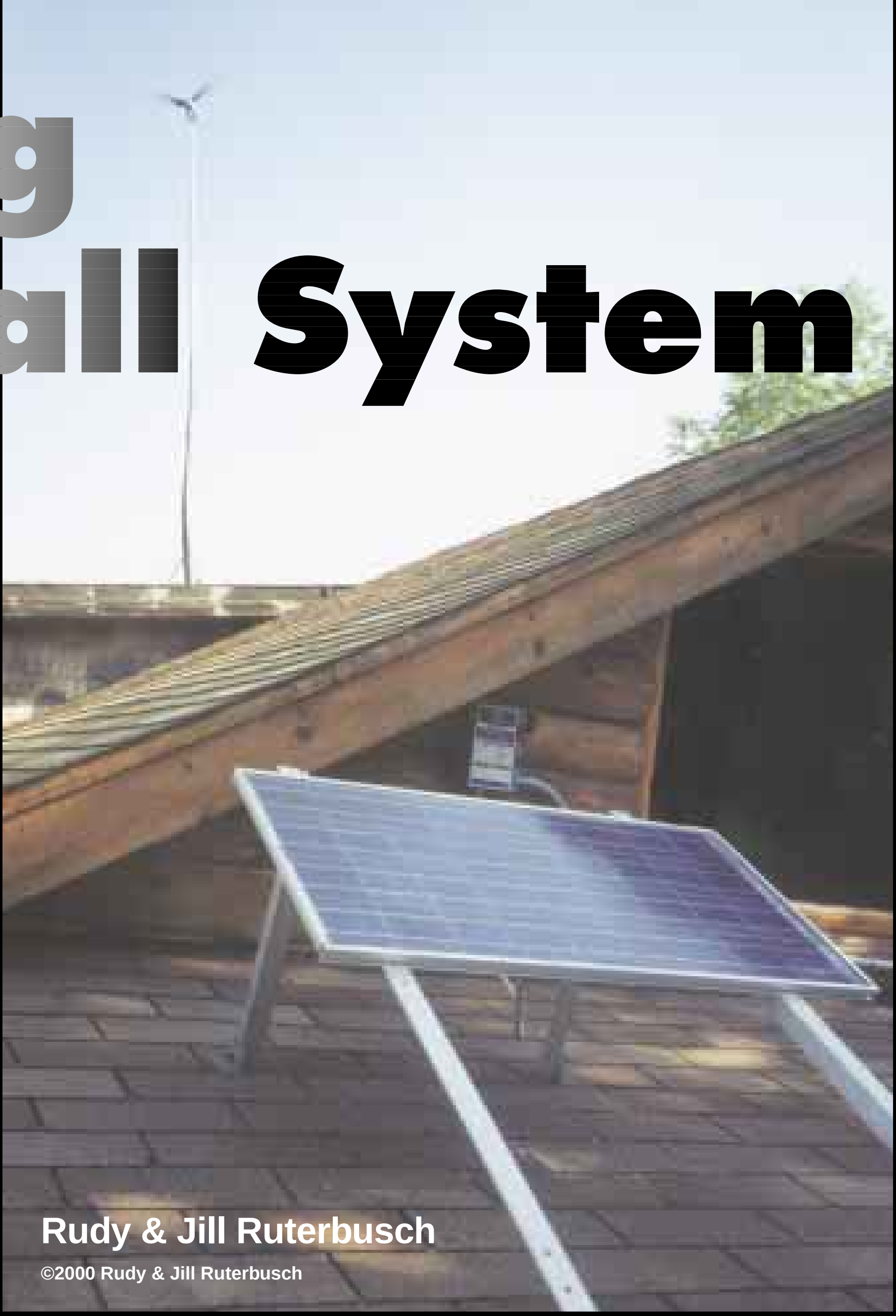
# Trying a Small System First



**Rudy & Jill Ruterbusch**



For several years we have lived in a small log cabin on our high bluff property near Frankfort, Michigan. We have marveled at the plentiful sun, breezy afternoons, and relentless surf that our corner of the Great Lakes offers. All the while, we imported our electrical power over a long thin wire, and wondered if there was some way to harness the energy around us.

After reading *Home Power* for a year, doing some research, and looking at a few boat and RV systems, we learned that it's possible. The problem was finding a way to measure just how much wind and sun we had. We considered putting up some measuring instruments, and then spending a year compiling data. For about US$1,000 you can put up a nice system that records data onto your computer.

We already had the power company keeping good records on our loads. If we had similar information on our available source, it would be simple math to design a system to produce our own electricity.

Then we thought of a better idea—take the $1,000 and build a small wind and solar-electric system instead. This way, we would have hands-on experience, a reliable backup power system for small loads, and already be producing some of our own power.

**System Design**

What was needed was a small wind plant, a small solar array, some batteries, meters, and DC loads we could use when power was available. We attended the Midwest Renewable Energy Fair in 1997, went to several workshops, and purchased most of our equipment right on the spot.

We selected the Southwest Windpower Air 303 because of its simplicity, size, and price. With its internal regulator, light weight, and two-wire DC output, it is a plant we felt capable of installing ourselves.

Next we selected the Solarex VLX-53 panel because of its size, cost, and appearance. While not mentioned in many articles, we thought it was important to select solar components that didn't detract from the natural beauty of our home and property.

We purchased four Trojan T-105 batteries for our energy storage. They were easy to find at a local golf cart repair business for US$52 each. The company also makes custom cables with #6 (13 $mm^2$) USE wire and soldered connectors very inexpensively.

Then after consulting with our local electrical inspector, we made up some wiring diagrams, applied for a permit, and purchased Square D breakers, boxes, and disconnects. Our inspector was very helpful, steering us away from possible problems before we laid the first piece of wire.

**Installation**

Our goal during the entire project was to stay as low-tech as possible. For the tower, we cut down a tall skinny tree in the woods. We erected it between two shorter, heavier poles that were cemented into the ground, much like an old flagpole. Using two large bolts, one became the hinge point for tilting the tower up and down, and the other held it in place while the guy lines were secured.

This temporary pole tower is 45 feet (14 m) tall. None of the obstructions (trees, cabin, etc.) extend above about 25 feet (8 m). Our cabin is on a little hill with falling terrain in three directions. It was a good spot for the wind generator, except for the noise. We've found a better permanent spot for a larger wind generator since then.

The tower wiring simply ran through a plastic conduit that was attached to the side of the pole, with a flexible section at the bottom to allow the tower to tilt up and down without disconnecting anything. Wires ran underground to the cabin from there.

The solar panel was mounted on a home-built rack made from 1-1/4 inch (3 cm) aluminum angle and some stainless hardware. The rack was built to hold two additional panels, which were added about a year later. It was attached to the porch roof on the south side of the cabin. It has adjustable rear legs to allow for summer and winter tilt settings. The wind tower top, solar rack, and main DC box were each earth grounded using separate ground rods and wires.

Our battery box was constructed of scrap plywood, with a hinged top for periodic inspection, and a removable front wall to make battery maintenance easier. The box is vented outside with a 3 inch (7.6 cm) flexible tube on one end. Air from the crawl space is allowed to enter the other end through a small screened opening. We also added Hydrocaps to all four batteries. So far, we have only added water once in over a year.

Once the battery box was installed, we ran a 30 amp service up to a six-circuit panel in the kitchen and connected some DC loads to the box. The low voltage under-cabinet lighting in the kitchen was simply rewired to the 12 volt box. We also wired in a radio, a fan, and a couple of small lamps with new cord ends and low voltage light bulbs.

Our system received final inspection and approval in the spring of 1998. All we needed was some wind and sun, and we didn't have to wait long.

**Charge Controlling**

After reading *The Complete Battery Book* by Richard Perez, we decided that the solar array could operate unregulated. As long as we limited its size to three panels maximum, the highest charge current would be about 9 amps, and with a fixed rack, that should only occur for three to four hours per day.

Our 440 amp-hour battery bank would never receive more than a C-50 charge rate after reaching full capacity. It would operate as a long, slow equalization during periods of high sun if we were away.

A small diode was installed at the disconnect box on the back of the solar array for each panel input to prevent nighttime discharging. I've checked the Hydrocaps on sunny days after returning home. You can hear them

**Four Trojan T-105 batteries, 440 AH at 12 VDC. Note the Hydrocaps, DC disconnects, and removable front wall on the box.**

**Ruterbusch System Loads**

| Item | Watts | Hours / day | WH / day |
|---|---|---|---|
| Kitchen light | 60 | 5.0 | 300 |
| Night light | 12 | 10.0 | 120 |
| Living room light | 25 | 2.0 | 50 |
| Radio | 8 | 4.0 | 32 |
| Bedroom lamp | 50 | 0.5 | 25 |
| Hall lamp | 18 | 1.0 | 18 |
| Porch light | 25 | 0.5 | 12 |
| Fan | 10 | 1.0 | 10 |
| Bathroom light | 20 | 0.5 | 10 |
| VCR tape rewinder | 40 | 0.1 | 4 |
| | | *Total WH per day* | 581 |

working, but they never get more than slightly warm. And the batteries never seem to get above 15 volts during these times.

**Low-Tech Data Logging**

Since the original idea was to measure our wind and sun, we needed to devise a plan to get the most information out of our low-tech instruments. Our data logger consisted of three ammeters, a voltmeter, a clock, and a notebook. Basically, any time the batteries were estimated to be in the upper third of their charge capacity, we used our DC loads at will.

Then whenever one of us walked through the kitchen, we picked up the notebook and wrote down the date, time, wind amps, solar amps, load amps, and volts. At the end of each week, we could interpolate our approximate watt-hours used, and add it to our annual running total. Occasionally during days of high winds and little sun, we would intentionally run all of our DC loads to extract all that was available from the wind plant, and take frequent readings.

We kept our log sheet next to the meters, and the load amp meter was read between five and thirty times each

**Ruterbusch System Costs**

| Qty. | Item | Cost (US$) |
|---|---|---|
| 1 | Air 303 wind generator | $500 |
| 1 | Solarex VLX-53 module | 265 |
| 4 | Trojan T-105 batteries | 208 |
| | Miscellaneous wire and hardware | 100 |
| 12 | Hydrocaps | 72 |
| 4 | Square D DC disconnects | 72 |
| 1 | Home-built PV rack | 45 |
| 6 | Square D breakers | 36 |
| 1 | Square D 6-circuit panel | 25 |
| | *Total* | $1,323 |

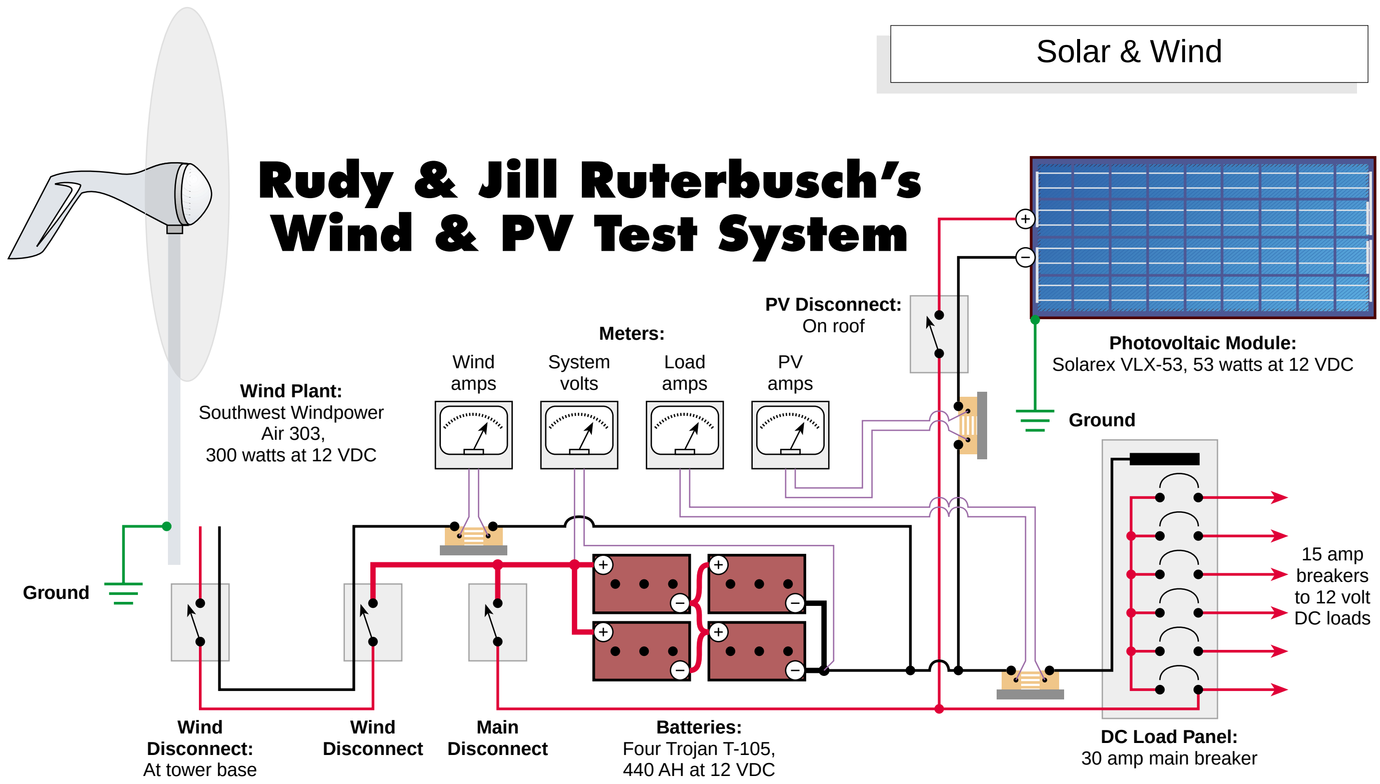
day. All the loads (except for the light we run all night in the kitchen) are only on when we are in the room using them. There are no phantom loads in our little system—it is all DC.

If we are gone for several days or more, all loads in the system are off. We didn't use these days for analysis, since there were no loads to balance against the charging available.

By comparing our data with wind reports from the local Coast Guard station hour by hour, we had a fairly accurate idea of what wind power was actually available. We could now take annual wind data from the National Weather Service and convert it into rough KWH of DC wind power.

The solar panel was much easier to estimate, since it followed a nearly identical curve any day the sun shined. We just had to keep track of rough hours of sunlight each day to compute solar energy available. It was all actually a lot of fun, and provided hours of discussion among our friends, neighbors, and family.

**Square D breaker panel with six circuits, DC meters, and wall switch for the 12 VDC light above. Box covers are removed for final inspection.**




## Results

Our data collection method is obviously not as accurate as actual data logging equipment, but it is fairly close. For about the same amount we would have spent on a data logging system, we are actually producing energy we can use now.

After collecting data for 18 months, expanding our solar array to 150 watts, adding additional DC loads, and watching our batteries very closely, we know we can rely on our little system to provide between 1/2 and 1 KWH each day. This is enough to run all the lighting on our main floor.

We have rarely cycled the batteries below 50 percent state of charge. On one occasion during a week-long family reunion, we had to connect a small battery charger to the batteries to compensate for high demand and low wind and sun. I liken it to running the generator for a day.

We have also learned that the wind at our site during the fall and winter is too much for our little Air wind plant. During storms, I have personally watched our little 300 watt whiz kid produce over 1-1/2 times its rated output for extended periods. It can only handle this abuse for several months before the regulator burns up. We have burned up several regulators in two years trying to make use of this natural power source.

The only two options appear to be upgrading to a stronger unit, or simply turning the Air off during inclement weather or while we are away. Our machine is currently in Flagstaff being upgraded to a model 403 for future use. The Solarex modules have performed flawlessly, and our batteries are holding up fine.

## Where We're Going from Here

With the information we now have, we have designed a system that should produce 120 percent of our total power needs. It will consist of a Whisper H-900 wind generator, a 1.2 KW solar array, and 50 KWH of lead-acid batteries. A Trace SW4024 will convert our power to AC. Last fall we applied and were approved for a wind energy grant from the state of Michigan. It will pay for about one quarter of the cost of our wind and battery system.

Two local dealers, John Heiss of Northwoods Energy, and Steve Smiley of Bay Energy Services, Inc., will be participating in our installation. We hope to have the wind system up and running by the fall of 2000. The solar array will be added the following spring. At the moment, a grid intertie is not planned, but we may do that in the future.

Since we do have grid power, we will simply use it in place of a generator for any power shortcomings, or for the occasional equalization. The small amount of money we pay to maintain grid power is acceptable to us under the circumstances. It's actually less expensive than purchasing and maintaining a gas or diesel generator.

## Successful Test

In the end, we much prefer building a small system from scratch to going cold turkey into a large one. It was fun, we learned a great deal, and it didn't cost any

Jill and Rudy, ready for a larger system.

more than we would have spent on a data logging system. It provided us with backup power during power outages, and we got the information we originally wanted.

Our small test system will remain in place even after we finish the larger one. It can still run our lights and other DC loads, and it will offset about 10 percent of our electric demands from our future equipment. We recommend it to anybody on the fence about going renewable.

**Access**

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