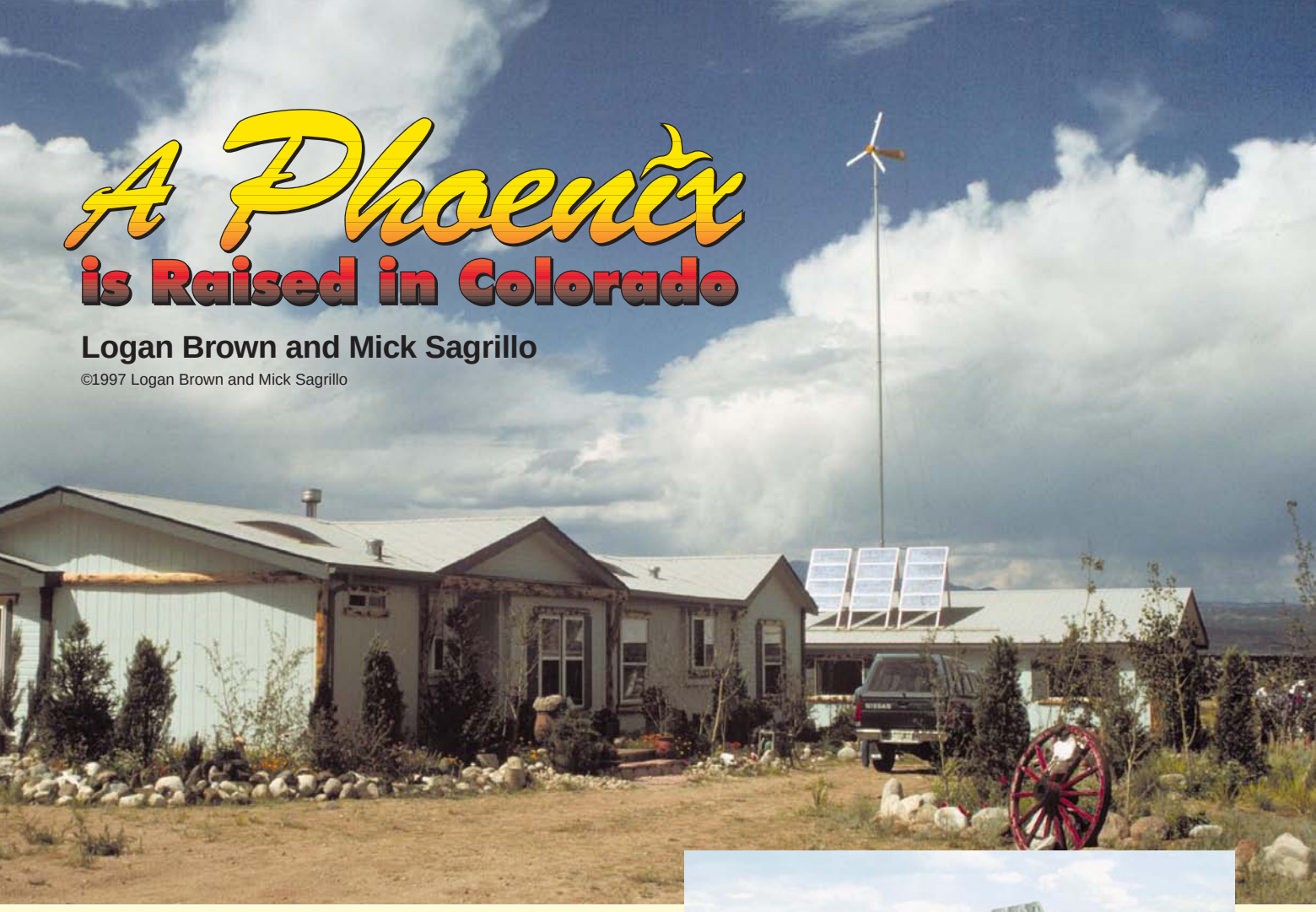
A Phoenix is Raised in Colorado

Logan Brown and Mick Sagrillo



Pat Preston's wind generator fell from its tower and crashed onto the roof of her garage. This occurred less than one year from when she had the wind/PV hybrid system installed at her Colorado home. Bolstered by a steadfast faith in renewable energy, and with technical assistance from Lake Michigan Wind & Sun and a passel of students from Solar Energy International, Pat has her wind/PV system flying again.

Left: The hard-worked crew, including Mick Sagrillo (left-front) and Pat Preston (third from right).

Why Renewable Energy?

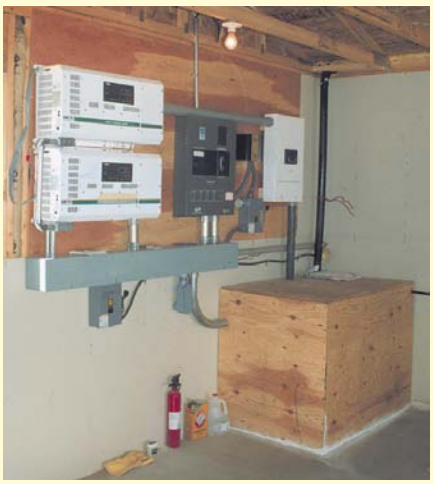
Pat's home is situated on a semi-arid plateau between Buena Vista and Salida, in central Colorado. There are few trees and a prevailing westerly wind that blows year-round, but hardest in the winter. The location provides an ideal solar site with an abundant wind resource. When asked why she chose renewable energy, Pat gives a quick answer, "Non-dependence on the grid." Self-reliance coupled with an unwillingness to pay $12,500 plus for access to grid power enticed her to go solar. She intuitively valued a hybrid system because, "the wind and sun compliment each other so well." A first-time independent energy producer, Pat initially felt leery about RE system maintenance and operation. "I'm computer and technology illiterate. But after living with the system for a short time, I became comfortable with it."

Setback!
Unlike most owner/operators who often experience a few minor problems in their first year, Pat's problems were not small or easily remedied. The wind turbine, a Bergey 850, was improperly installed by a local dealer. It fell from its tower and destroyed part of her garage, as well as itself, only months after installation. In a letter from Pat, she shared her thoughts on this accident. Pat wrote, "Running into a few snags, like my cherished Bergey blowing off its tower, did in fact diminish my spirits. However, the sense of freedom in experiencing power from the wind and sun was still strong, even after the disaster." Pat later said that she "had no reservations at all" about repairing her Bergey and having it re-installed.

Above: Pat enjoying some of her home-made electricity.

The PV Electric System
Pat's PV system consists of a dozen 51 Watt Kyocera panels wired in series-parallel to deliver 18 Amps maximum at 24 VDC nominal. The modules are rack-mounted on her garage roof, and permanently fixed at a 45˚ tilt. A 30 foot round trip of #8 stranded copper wire brings the array power into an Ananda APT-3 Powercenter. There is a weather-proof disconnect switch mounted on the module mounting rack. This allows a person to disconnect the PV's from the system when service is required on the array.

The module frames are grounded by a #6 bare copper wire attached to an eight foot copper ground rod driven below the garage roof drip line. This location insures adequate soil moisture in desert country.



Left: The control room in the garage. Note the "safety equipment" on the floor.

The Wind System
The second half of Pat's RE system is a Bergey 850 wind generator. The turbine is now mounted atop a 64 foot tubular guyed tilt-up tower. The tower is made of 4 inch Schedule 5 galvanized steel pipe, guyed every 20 feet. It is located approximately 30 feet from the garage. The Bergey 850 has a rated output of 850 watts at a wind speed of 28 MPH. This translates to 35 Amps maximum at 24 VDC nominal. Nearly 190 feet (round trip) of #4 stranded aluminum cable delivers power through a three phase 30 amp safety disconnect switch protected by a lightning arrestor. From there power travels through the standard Bergey regulator and into the batteries. Note the disparity between the 35 Amps DC charging current of the Bergey and the 30 amp safety disconnect. This is because the Bergey produces three phase ac current, with each wire seeing only two thirds of the maximum DC charging current. The safety disconnect is on the ac side of the controller, not the DC side.

"Phoenix" Flies Again
Pat's wind generator was originally mounted on ten feet of four inch water pipe. The pipe passed through the garage roof and was bolted to the gable end wall. As a result of this improper installation, the Bergey vibrated violently and soon fell, causing considerable damage to both her garage and the wind generator. That these were the only things damaged by the fall was a blessing (see side bar). Now properly installed, Pat says the wind generator is "operating quietly and working wonderfully."

Above: Students learn how to use a transit from Johnny Weiss.

Part of the students' responsibility in this workshop was to leave Pat with a working wind system. Johnny and Mick worked with Pat for months beforehand so that all was choreographed and the installation would go smoothly. Together with Pat, they laid out the anchor location for the tower. Pat then hired a backhoe to dig the holes for concrete. Pat's soil is quite sandy and rocky, and standard screw-in anchors were inappropriate for the site.

The students wheelbarrowed concrete from a truck and trued the anchors before the cement set. Later in the week, they assembled the tower, raised it, and leveled it with the aid of a transit. The tower was lowered so that the Bergey 850 and wires could be installed. The wiring was buried in PVC conduit, brought into the garage, connected to the Bergey controller, and then to the batteries.

Eight foot ground rods were driven at five locations around the tower, at each of the four anchors plus the tower's base. After a final check, the tower was again raised and the 850 began pumping electricity into Pat's battery bank.

Batteries

The batteries, along with all power conditioning equipment, are located in the garage. Pat's RE electricity is stored in 16 six Volt, 350 Amp-hour Deka lead-acid batteries. The bank is wired to provide 1400 Amp hours of storage at 24 VDC. They are located beneath the APT-3 in an insulated wooden battery box that is vented to the outside. The 2/0 battery interconnects were neatly installed by the original dealer. For safety, Pat wisely keeps a large box of baking soda, rubber gloves, safety glasses, and a fire extinguisher nearby. Servicing the batteries is a bit difficult because of the size of the battery box. The batteries are fitted tightly into the wooden enclosure. This looks neat, but leaves little room to access individual cells for routine maintenance or removal.

Above: Pouring concrete for the footings.

Inverters

Two Trace SW4024 inverters are wired together to provide both 120 and 240 vac. Each Trace is individually connected to the battery bank and has its own disconnect. The second was installed so the existing 240 vac water pump could be operated. Pat could have done without the second inverter if she had replaced her pump with a 120 vac unit, but she appreciates the security and greater capacity that two inverters provide.

The inverters, Powercenter, and all safety disconnects had their chassis interconnected with a #6 bare copper wire. This wire and the ground wire from the lightning arrestor were connected to an eight foot ground rod driven below the garage roof drip line.

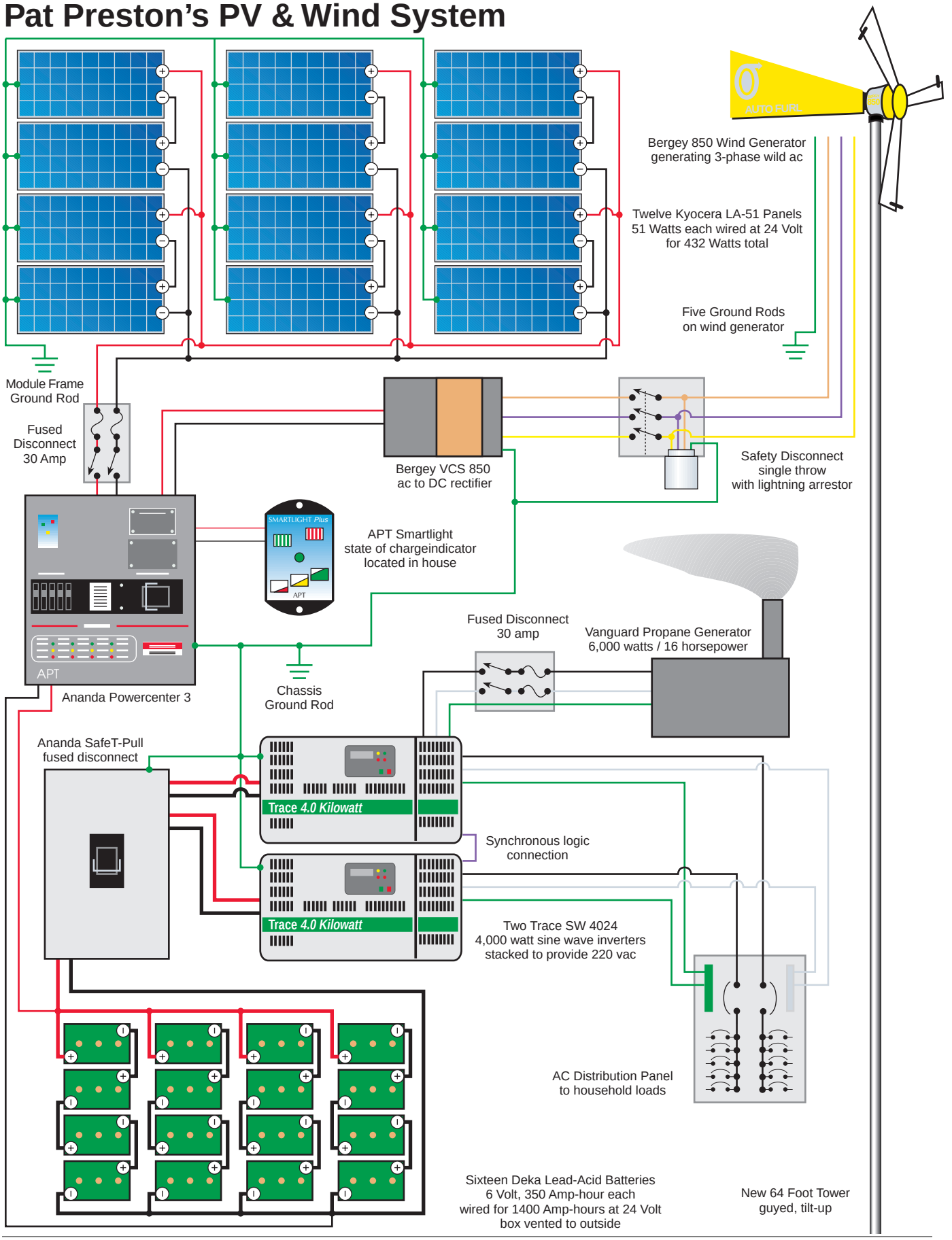
Tune-up

The students, under the expert guidance of SEI's Johnny Weiss, proceeded to examine and fine tune the battery, inverter, and control subsystems. For example, the specific gravity of all of the battery cells was checked and recorded, and all terminals cleaned and tightened. Controller set points were adjusted and all wire connections checked. Finally, the Trace inverters were reprogrammed.

Pat's only problem with the inverters was the result of poor education and communication, so she eagerly participated in the tune-up. Originally, some of Pat's smaller loads, particularly the compact

Below: Going over final measurements before the "mud" sets up.

Pat Preston's PV & Wind System



Above: Preparing the Bergey for raising...

Right: ...and up she goes!

fluorescents, would not start when individually turned on. When we examined the “search watts” setting on the Trace, we found that it was set too high for her smaller loads to trigger the inverter start-up. The inverter would remain “asleep” unless a larger load was turned on. This was remedied by bypassing the “search watts” option, leaving the inverters on all the time. Having the inverters constantly “awake” causes a negligible daily load increase.

Genset

Stored in a shed built onto the outside of the garage, Pat keeps a Vanguard 16 kw Briggs and Stratton propane generator. While the Bergey was out of service, the generator was used frequently to help charge her battery bank through the built-in 120 Amp battery charger in the Trace. Now that the wind generator is up and spinning again, the generator has never run to charge the batteries. However, it is started occasionally for maintenance purposes. Inside the garage with the rest of the system controls, there is a separate 120 vac 30 amp safety disconnect switch for the genset.

Power Controls

The PV charge controller is inside the Powercenter 3. Its charge termination point is set at 29.3 V. The Bergey 850 has its own charge control unit, a Voltage Control System (VCS) 850. The VCS 850 charge termination point is set at 27.6 V. Under this set up, the Bergey, along with the PV’s, supplies bulk power to the batteries while the PV’s are responsible for the float or trickle charge.

Unlike other wind generators, the Bergey 850 does not need a diversion load when there is excess charging power. Instead, the VCS 850 disconnects the Bergey from the batteries, similar to a PV controller. The flexible pitch blades and auto-furling tail mechanism on the Bergey are designed to allow it to safely operate under such no-load conditions.

Right: Making sure the tower is plumb.

Below: Tensioning the guy cables.

Leftt: Installing ground rods. Author Logan Brown stands at far right.

Pat Preston's RE System Cost

Wind system components	*Cost*	*%*
Bergey 850	$2,195	9.2%
64 foot tilt-up tower	$1,210	5.1%
Labor (SEI administrative fee)	$750	3.2%
Backhoe to excavate holes	$370	1.6%
Concrete for footings	$300	1.3%
190 feet #4 aluminum "tri-plex"	$115	0.5%
Freight for the tower	$100	0.4%
Conduit and misc. connectors	$77	0.3%
3-phase safety disconnect	$50	0.2%
3-phase lightning arrestor	$50	0.2%
Kellums "tri-plex" supports	$43	0.2%
Total wind system installed cost	$5,260	22.1%
PV system components	*Cost*	*%*
12 LA-51 Kyocera PV panels	$4,548	19.1%
Roof mounts	$237	1.0%
Safety disconnect for array	$50	0.2%
Wire for run and interconnects	$38	0.2%
Surge arrestor	$10	0.0%
Total for PV "generator"	$4,883	20.6%
Balance of system components	*Cost*	*%*
2 Trace SW4024 Inverters	$5,960	25.1%
16 Deka 350 Ahr 6V batteries	$2,800	11.8%
16 hp 9 kw Vanguard gen-set	$2,200	9.3%
Ananda Powercenter 3	$995	4.2%
Miscellaneous parts	$898	3.8%
SafeT-Pull disconnect	$255	1.1%
Original Bergey "tower"	$250	1.1%
Battery interconnects	$162	0.7%
Safety disconnect for gen-set	$50	0.2%
Smartlight Plus	$39	0.2%
Total for B.O.S.	$13,609	57.3%
Grand total	$23,752	

Note: Labor costs for PV and BOS installation unknown.

Lessons Learned

The original Bergey “tower”

When Pat originally contacted the local RE dealer about installing a wind/PV hybrid system, he told her that he would be willing to install the wind system, but it would be his way. Because this dealer had no experience with towers or wind generators, that meant installing the Bergey 850 on a piece of water pipe attached to Pat’s garage wall. The photo shows the original Bergey installation.

Pat had seen other wind installations, and knew that wind generators were always mounted on towers. However, against her better judgement, she deferred to the dealer’s decision in mounting the generator. In hindsight, Pat now believes she should have contacted another more experienced dealer.

Trouble began almost immediately when the wind generator began spinning. The Bergey set up a resonant frequency (as does any rotating electrical generating device) whose sound was amplified by the hollow structure of the garage. This is not unlike the amplification of sound in a guitar when you pluck a string. The sound was so loud that Pat could hear it constantly in the house with all doors and windows closed.

Next, she noticed that some of the ceiling braces in the garage were loose. A carpenter was contracted to re-nail the braces and add extra cross braces so that the garage would not disassemble itself. The SEI students found that the plywood upon which the Trace inverters, Ananda Powercenter, and electrical wiring were mounted was barely attached to the garage walls. The vibration had shook the nails almost completely out of the plywood. This is lesson #1: wind generators are mounted on towers, not on buildings.

Additionally, the original dealer decided to mount the Bergey 850 on a ten foot piece of water pipe, rather than secure the proper tower tubing as specified by the factory. The wind generator’s mounting bolts were too short for the thick water pipe, but were used by the dealer anyway. Within a few months, the mounting bolts vibrated out of the water pipe, and the Bergey fell from its perch. In the

process of tearing up the garage roof, the Bergey sustained considerable damage, including three broken blades. Lesson #2: install wind systems only on factory approved mountings.

When contacted about all of this, the original dealer contested everything, including the expertise of the manufacturer, Bergey Windpower Company. It looked like Pat would get stuck holding the bag for the damages incurred, just over $1000 plus shipping. As it turned out, the original dealer's distributor agreed to pay the damages, but only after some careful negotiations. Hopefully the original dealer has been cut off by the distributor. If so, it would be for a just cause. While Pat got her Bergey repairs paid for, she did have to shell out a comparable amount to repair the garage. Lesson #3: the obligation of a dealer is to respect your customers and stand behind your installations. Problems can occur with even the best of installers. When mistakes happen dealers should own up to them, learn from them, make good on them, and move on, all the wiser for the experience.

And finally, lesson #4: homeowners should not be afraid to question a dealer about what he or she is doing. Notice I said "question" and not "challenge." If you don't feel comfortable with the level of expertise of the dealer or installer, look elsewhere for a qualified person to do your work. However, take time to explain to the first dealer the reasoning behind your decision. You may even want to recommend SEI as a place for a novice dealer to get some practical hands-on experience.

—Mick Sagrillo

Metering

The metering in Pat's system consists of the battery voltage meter available on the Trace inverter control panel and an APT Smartlight installed in her house. While the Smartlight quickly lets her know basic information about her battery bank's voltage, Pat's personal interest in her RE system has left her wanting a more detailed and informative remote meter. Pat's abundant wind resources allow her to equalize her battery bank quite often, and she would like to be able to monitor her battery voltage without having to go to the garage. A Bogart TriMetric or a Cruising Equipment E-Meter, for example, would fit this system's needs well.

Moving on…

Pat's property is now for sale. She reports having encountered some hesitation from potential buyers, but no outright refusals as a result of the renewable energy system. "Having this much charging capacity is like being on the grid," she said. When asked if she would install a renewable energy system on her next home, Pat replied, "I'll definitely do it again. I'm planning on doing some traveling, though. Can you help me put PV's on an RV?"

Thank You

Besides being an eager student, Pat is an enthusiastic RE owner who unquestioningly allowed the SEI students to poke and prod at her wind and PV systems. Lake Michigan Wind & Sun and Solar Energy International are grateful for her support and hospitality in hosting this installation workshop. Pat is a Phoenix in her own right. May her days be filled with sunny mornings and breezy afternoons.

Access

Author: Logan Brown is an intern (soon on his way to Russia as a Peace Corps volunteer) at Solar Energy International, PO Box 715, Carbondale, CO 81623 • 970-963-8855.

Author: Mick Sagrillo is a wind technology specialist at Lake Michigan Wind & Sun, E3971 Bluebird Rd., Forestville, WI 54213 • 414-837-2267
E-Mail: LMWandS@ITOL.com

A Testimonial by Logan Brown

Interested in learning about solar and wind power?

As a college student interested in energy conservation and alternative sources of energy, I certainly was. While working for the National Wildlife Federation after graduation, I discovered Solar Energy International (SEI). SEI is a non-profit organization whose mission is to provide education and technical assistance to encourage the use of renewable energy.

After enrolling in their entire Renewable Energy Education Program (REEP), I moved to SEI's headquarters in Carbondale, Colorado. I participated in workshops on photovoltaics, micro-hydro, wind power, and solar home design. I had no prior training in renewable energy before I came to SEI. However, the hands-on nature of the workshops helped me learn quickly.

Our wind workshop was instructed by Mick Sagrillo of Lake Michigan Wind & Sun. Under the direction of Mick and Johnny Weiss, Director of SEI's REEP program, sixteen participants spent one week in SEI's classroom/lab learning the basics of wind technology. The second week of class was spent installing two wind generators at private residences in Colorado. Our first installation was a Whisper 1500 that we put on a tilt-up tower. The second installation, at Pat Preston's home, is described in the accompanying article.

SEI's next Wind Power Workshop is July 21-August 1, please contact: SEI, PO Box 715, Carbondale, CO 81623; phone 970-963-8855, fax 970-963-8866, or E-Mail sei@solarenergy.org.