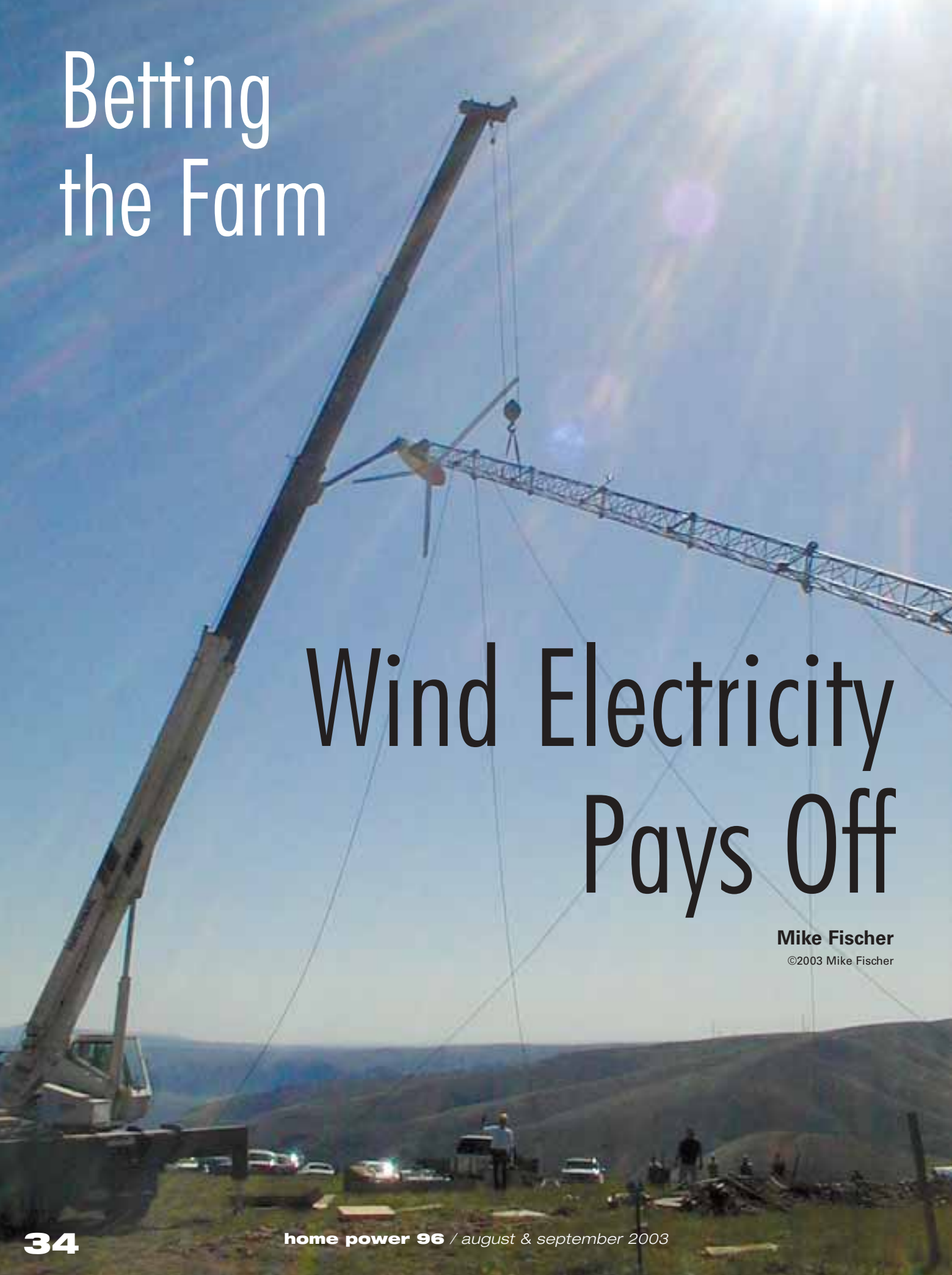
Betting the Farm

Wind Electricity Pays Off

Mike Fischer



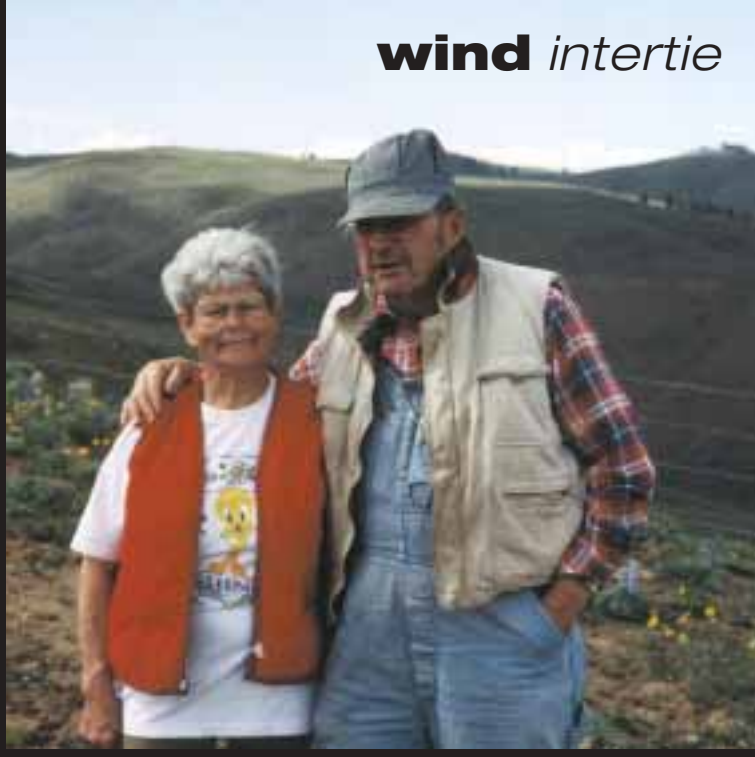
In spring 2001, June and Charlie Nichols met with Brooks Solar to discuss putting up some solar-electric panels on their property. What ended up happening just might be the best retirement present anyone could get.

Anne and Randy Brooks of Brooks Solar, Inc. in central Washington state have a systematic approach to helping others tread lightly on the earth, based on cost effectiveness. When dealing with a prospective client, they first recommend conservation, followed by an efficient, south-facing, passive solar home design. Next they recommend using solar hot water, since water heating accounts for the equivalent of about 20 percent of electrical consumption. For electricity production, they recommend a microhydro system as the first choice if you have falling water, then exploration of your wind-electric potential, and consideration of solar electricity last because, comparatively, it's the least cost effective of the options.

Going through this process got June and Charlie to thinking about when a large stack of hay bales was blown down their ridge, even though it was tied down with barbed wire, tarps, and old tires. They also remembered the time some pasture seeds blew a half mile to a neighbor's property. They became intrigued by wind power. Charlie was already predisposed to wind—in the 1940s, his family used a windmill to run a pump to get water to their 300 head of cattle.

Then the greatest selling point of all unfolded. The local utility's renewable energy incentive program, Sustainable Natural Alternative Power (SNAP), will pay producers in Chelan County up to US$1.50 per kilowatt-hour.

After a few calculations, Randy told June and Charlie that through the SNAP program, they could pay off their system within three to five years. After monitoring the progress of SNAP contributions, the Nichols made their decision in January 2002. They chose a grid-connected, 10 KW, Bergey Excel turbine, with a 21 foot (6.4 m) rotor diameter, on a 100 foot (30 m) guyed lattice tower.



June and Charlie Nichols chose wind as the power generating resource for their ranch in Washington.

Site Evaluation

The proposed turbine location had no trees to check for wind flagging. Older wind resource maps indicated that the exposed ridge experienced class 4 winds (13.4–14.5 mph; 6.0–6.5 m/s average) and newer maps indicated class 3 winds (12.3–13.4 mph; 5.5–6.0 m/s average). But both are mathematical extrapolations that might not define the site's actual microclimate. June and Charlie decided to forgo potentially sophisticated (expensive) wind measurements and follow their gut by putting up the Excel.

Laying out and bolting together the ten, 10 foot tower sections.

Rolling out the guy wires.

Later, after the trench to the power shed had been dug, Randy noticed that there was no topsoil on the ridge at the turbine site, but several feet of topsoil down by the shed. Also, the wildflowers and sage on the southeast sides of the hills in this high desert area were robust, while there was stunted vegetation on the ridge at the turbine site. All these subtle indications, combined with Charlie Nichols' experience in this country, pointed to the likelihood of consistent winds on the ridge.

Pre-Installation Preparation

June and Charlie contracted out with a neighbor to dig the trench and the holes for the guy wire anchors with a backhoe. Randy later dug the slots for the sloping anchor rods by hand to reduce disturbance of the soil on the tower side of each anchor hole. After fighting with the rocky soil, Randy concluded that he'd have a backhoe do this next time. The three anchors were located so that two shared the load of the prevailing winds on this fixed tower. As recommended by the manufacturer, a 50 foot (15 m) guy radius was used.

It was thought that direct burial electrical wire would be best to use. But after doing it, Randy decided that it was not worth the extra labor to fill in the rocky sections of the trench with sand, and then lay the wire and cover it with sand and caution tape before backfilling the hole. Conduit with ground wire running outside it will be Randy's preferred method next time. Three, #2 (33 mm^2) transmission wires and a #8 (8 mm^2) copper ground wire were run 924 feet (281 m) from the tower base to the inverter.

Portable power runs tools on the site.

Weather & Logistics

Only one paved road leads to the Nichols ranch, and a spring thaw load restriction was in place that delayed the project and required a special permit for passing over the road with the concrete truck and semi that would deliver the turbine and tower.

After the weather settled down, the turbine and tower were delivered, but the blades and inverter were missing. A few weeks later, a second set of pultruded fiberglass blades were air freighted from the Bergey factory in Oklahoma and the inverter arrived shortly after from the Trace factory in California. The original blades are still missing. Only one year after June Nichols approached Brooks Solar, and after three months of installation preparation and delays, the tower and turbine were set to go up.

Installation Crew

Randy Brooks, who traveled to Norman, Oklahoma before the installation to be trained as a Bergey installer, led the crew. This is first and foremost why the installation and grid-intertie went so well. You know how some people have their ducks in a

The crane holds the weight while the Bergey Excel is bolted to the tower top.

Muscling the Bergey's tail into position.

row? Well Randy knows what temperature the ducks like the water, and you can rest assured that the pond will be just that. He is an asset to the industry!

Rose Woofenden, and her dad Ian, came over from western Washington to help. Rose was born in a wind and solar-electric powered house, and Ian works for *Home Power* and coordinates workshops for Solar Energy International (SEI). Kelly Keilwitz of Whidbey Sun & Wind, also a Bergey dealer, traveled over the mountains with the Woofendens to help. Bill Hoffer, an energy efficiency and renewable energy consultant who often collaborates with Brooks Solar was on hand as well.

Randy Brooks and the owners were willing to allow the installation to be a demonstration project. Northwest Sustainable Energy for Economic Development (NW SEED) invited a group of individuals to monitor the installation. The group included a solar equipment distributor in Oregon interested in getting into the wind industry, a business development director for a general contractor from central Washington, and an SEI graduate and Bergey certified dealer from Spokane, among others. All fees the NW SEED participants paid were used to offset the cost of the installation. In return, June had an endless flow of coffee, snacks, and sandwiches for all.

Overcurrent protection at the tower's base.

Volunteers included Lance Moore, an electrician from Whidbey Island who wanted to gain some RE experience; Ed Kennell, part of the energy program at Washington State University's Cooperative Extension, and whose knowledge and equipment from two and a half decades in the wind industry were indispensable; and me, another SEI intern/graduate, there for documentation and experience.

Installation

On Monday, April 29, 2002, the crew and volunteers headed up into the high desert of Malaga, Washington to the ranch. After setting up camp, Randy oriented us by showing the first cut of a Bergey installation video, and mentioned updates both to it and the installation manual.

Mounting the blades using an impact wrench.

On Tuesday morning, we woke to the loud squawking of guinea hens. We headed up the wildflower littered hill to the turbine location. It was a gusty day on the ridge, which was both encouraging and a bit worrisome. No one wanted to work in high winds the next day when the crane would show up.

After the NW SEED folks arrived, Randy had an orientation and safety briefing, and also explained the SNAP program. Our first task was to assemble the ten, 10 foot (3 m), 250 pound (113 kg) tower sections. We found it best to rest the tower sections on pieces of 4 by 4s to keep dirt out of the holes. The ground was sloped and wavy, so

Ready to raise.

we had to wiggle the sections and use drift pins to get all the holes to line up to connect the sections.

After assembling the tower and torquing the bolts to 150 foot-pounds each, we ran the transmission wires through the tower, and tied them to a tower leg with zip ties. As the wires were run through the tower, the equalizer plates were being attached to the anchor rods. The equalizer plates help evenly distribute the load from the guy wires to the anchor rods. Then the guy wires were laid out from the tower, a pair running to each anchor rod set at 50 feet and 90 feet (15 and 27 m) on the tower.

After all the wires were run, the junction and disconnect box was attached at the base of the tower, as was a Delta LA603 lightning arrestor and the furling winch. Bergey installed plates at a comfortable height on the bottom tower section to attach the winch and junction box. The furling winch allows someone at the base of the tower to move the tail 70 degrees, taking the turbine out of the wind. The tail has a shock absorbing system that prevents the tail from snapping back into position after releasing the winch, to prevent unnecessary wear and tear on the machine.

Down in the shed, Lance was wiring the inverter and replacing the #8 (8 mm²) ground wire from the service disconnect to ground rods with #6 (13 mm²) to comply with code. Lance also used wire pulling lubricant to snake the #2 (33 mm²) wires from the system disconnect to the inverter. This stuff is messy, but easy to clean up and worth its weight in gold. A lot of sweat and many a smashed knuckle has been saved by this goop.

By the end of the day, the tower was ready and everything was in place for the crane to come in—everything except the tail, that is. Charlie's granddaughter was painting his cattle brand on it.

Crane Day

Fortunately, the sun was shining and the winds had died down for the tower raising. Lance finished all the wiring for the inverter and second disconnect, located down by the shed. Duncan Crane Service out of Moses Lake showed up right on time, and everything was ready. The crane was positioned between two anchors on the uphill, prevailing wind side of the tower.

Going up.

Snagged on the crane.

Bill Hoffer brought an inverter and Randy brought some batteries, charged from his Bergey XL.1 wind machine at home, to provide remote power for electric tools on site. This came in handy when a little on-site engineering was needed to help hold the tower off the ground. Randy used his Sawzall to turn the 4 by 4 framed turbine-shipping pallet into a brace for the tower.

This freed up the crane to lift the 1,060 pound (481 kg) turbine head, so we could bolt it to the tower. The crew lined up all the holes, making sure that the furling cable and electrical wires were all aligned properly. Once the turbine was attached, Randy used a RotoFlex to strip the metal casing around the wire housing, setting the depth so that it didn't cut the wires. All the final wiring was completed, the furling cable was attached, and we caulked around the electrical box on the turbine head.

After all the bolts were properly torqued, it was time to put the branded tail on. This was a snug fit to say the least. The 145 pound (66 kg) tail was supported by the crane, and with some extra elbow grease, the pivot pin was inserted into its hole on the turbine. Then it was time to attach the blades. Anti-seize compound was used on the bolts to prevent rusting and seizing, and CRC SP-400 severe environment corrosion inhibitor was sprayed on the alternator to keep the blades from sticking to it. After using an impact wrench to torque down the blade bolts, we were ready to raise the tower.

The strap from the crane was attached at 80 feet (24 m). The position of the assembled tower and crane allowed the

Putting the base in place.

Chelan County PUD SNAP Program

Senior energy services engineer Dr. Jim White of Chelan County PUD instituted the SNAP program in 2001. Local utility customers pay a voluntary amount, from US$2.50 to US$50 per month, to support locally generated, grid-connected, clean electricity. The program is designed for small producers only, with a maximum rated generation capacity of 25 kilowatts each. Producers are paid a percentage of the pool based on their percentage of the total renewable KWH generated.

All the money donated for the SNAP program goes directly to renewable electricity producers. Chelan County PUD covers promotional costs separately. The SNAP program collected US$30,000 its first year, and rolled over US$9,000 to 2002. To reduce administrative costs, SNAP producers are paid once a year (on Earth Day).

Jim White hopes that other counties and states have the foresight to establish programs similar to SNAP. Think of what could happen if participating generators all across the country were paid up to US$1.50 per KWH from a voluntary fund. The SNAP plan might be a more effective incentive than ordinary net billing plans.

"What happens in the future depends on customer participation," White said. If customers are eager to support renewable energy, producers will be eager to generate it. That's what's unique about the program," he added. "It allows customer demand to set the supply. If enough PUD customers sign up to pay a little more on their bills each month, we can show the world that these renewable energy technologies are cost effective today, even here in Chelan County, where our electric rates are among the lowest in the nation."

While the PUD is not funding local producers per se, the utility is lending its expertise to potential producers, and providing a means for consumers to support renewable energy. SNAP is a rate-neutral, pay-as-you-go system. It will not affect the electric rates of customers who do not want to participate.

Tensioning the guy wires and plumbing the tower.

crane to make a straight-up lift without reaching too far out, which limits how much weight the crane can lift. The crane dragged the base until the whole assembly was vertical.

As the crane lifted the tower closer to the tower base, we heard a loud snap. Hearts started pounding and eyes got big as we covered our heads. The crane strap was attached incorrectly such that one horizontal girt bore the entire weight of the tower and turbine when the tower became vertical. The girt couldn't hold it and broke, allowing the tower to be supported more evenly. The broken girt was later replaced.

Just as the tower was close to vertical, there was a delay and we couldn't figure out why. One of the many onlookers (local television and newspaper crews as well as curious friends) saw that the top of the crane had become stuck in the tower. After a little finagling, the crane operator got it loose, but we later concluded that the crane's swing out boom, which had fewer things to snag on the tower, should have been used.

The tower was placed on a pin in the concrete base and turned to line up with the wires coming up out of the trench. We secured the tower with cable clamps on the guy wires, and Randy became the first to climb the tower when he released the crane strap. The crane headed home, and we took a well-deserved lunch break, but we still had lots of work to do.

The tower was plumbed (made vertical) with an elevating transit, adjusting turnbuckles at each anchor. The crew tensioned the guy wires, using the oscillation method. To do this, you twang the wires and count the oscillations, and adjust the tension based on a formula using the guy wire length. After final guy wire tensioning, ground rods were connected to each anchor rod, electrically grounding each guy wire. The turbine disconnect was wired, and it was time for commissioning tests.

The turbine started spinning and there were smiles all around. Ceremonial tower climbing allowed for sweeping vistas of the high desert country, and we were proud of a job well done.

Connecting to the Grid

Chelan County PUD responded quickly and arrived Friday morning to connect the approved system to the grid. After connection, grid voltage was checked and the inverter was turned on. The system started flawlessly and became the first grid tied wind turbine in Chelan County, and the first wind turbine to supply

Climbing to unhook the crane.

The Nichols' ranch as seen from 100 feet up.

State. She obtained a state tax number and registered as a business to qualify as part of the SNAP program.

The turbine was connected to the grid on May 3, 2002. On March 27, 2003, the PUD read the meter, recording the Nichols' production at 7,222 KWH for the first eleven months. Their check was for US$8,590, or US$1.19 per KWH. That's a pretty good chunk of change—just short of a quarter of the cost of their installation.

There is hope for utilities. People like Jim White from Chelan County PUD and groups like NW SEED are helping pave the way for a sustainable energy future that helps local economies by supporting locally generated clean electricity. As June says, "It's the right thing to do."

Wind System Costs

Item	Cost (US$)
Bergey equipment (turbine, tower, inverter, tower wiring kit)	$26,400
Labor	4,000
Materials (forms, rebar, concrete, wire, conduit, etc.)	3,000
Owner services (permits, excavation, freight, PUD connection fee)	2,400
Equipment rental (compactor, crane)	2,000
Total	$37,800

electricity to the Chelan County PUD SNAP program.

The electrical wiring to connect the turbine to the utility is straightforward. There is a turbine disconnect at the base of the tower and an extra one at the power shed (so nobody has to walk up the hill to disconnect the system). The Excel produces 240 V, three-phase wild AC that runs from the tower to the inverter.

The inverter takes the wild AC and converts it first to DC and then to a grid-synchronized AC output. From the inverter, the system is wired to a fused service disconnect and production meter. June and Charlie get paid for what they produce, regardless of their farm's consumption. From the production meter, the wires run to the transformer on the utility pole.

Betting the Farm

June and Charlie were able to secure a 6 percent low-interest loan from Key Bank to pay for the installation, using the farm as collateral. June waited till after July to order and purchase the equipment, when a sales tax exemption for RE equipment took effect in Washington

The hard-working crew pauses for a group photo.

Access

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Check the wind resource for Pacific Northwest locations at www.windpowermaps.org, and see other wind maps at www.homepower.com/windmap.htm