Rezabek Case Study 5-04.qxp 5/24/2004 10:52 AM Page 1

RENEWABLE ENERGY

Owning a PV/Wind Hybrid System: Being Your Own Utility

CASE STUDY

BIOMASS

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HYDROPOWER

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The Rezabek/Strous house is conventional in appearance and amenities but unusual in its independence from the utility power grid.

by Mick Sagrillo

Like many others from the city, Cheryl Rezabek and Bob Strous sought refuge from the fast-paced city life, saved their money, bought a beautiful piece of property, then set about designing their dream home. All went well until they got an impossibly expensive estimate from the local utility for extending an electric line to their property. Stunned by the quote but undaunted in their plans, they set about searching for alternatives. This is when they began to learn about options available for generating renewable electricity.

The couple researched their options for both solar and wind-generated electricity. With excellent solar exposure during the spring, summer and fall, photovoltaics (PV) was a logical choice. Sufficient winds caressed their property over the fall, winter and spring to make a wind turbine practical as well. Peaking at opposing ends of the year, their wind and solar resources seemed very compatible. So, instead of choosing one or the other, they concluded that installing a hybrid wind/PV system would just about eliminate the need for their propane-fired generator.

Their modern 2,400-square foot, conventionally constructed home was built in 1993. A 5-kW generator provided site power for construction. That experience audibly illustrated a second advantage of renewably generated electricity: it would be quieter than a generator's relentless drone whenever electricity was needed. Once their PV array was up and working, the generator sat unused and silent.

The Rezabek/Strous PV system consists of a fixed rack mounted with 1.2 kW of Solarex modules. The PV panels feed a 24-volt DC (direct current) battery bank. Everything but the Sunfrost DC refrigerator was powered through inverters, so that standard AC (alternating current) appliances could be utilized. Their PV system cost them $25,550 in 1993, including installation. Today a system of this size may actually cost less as prices have been falling, while the system component quality of has improved.

The next year, the couple installed their wind system. Their choice was a Whisper 1000, a two-bladed 1,000-watt turbine that was then manufactured by World Power Technologies. The Whisper was mounted atop an 80-foot tilt-up tower. The wind system with controller, tower and installation was an investment of $8,685.

A tilt-up tower is anchored by guy cables and tilts to the ground when the wind turbine needs servicing. The advantage of this type of tower is that climbing is not necessary. However, with the guy cables and the amount of space the tower requires as it's laid down, this tower needs a sizable open area to function as it should.

Due to the long distance between the tower and the battery bank and the power losses this would entail, Rezabek/Strous opted for a high voltage/low voltage (HVLV) package. In this system, the wind turbine actually generates electricity at 240 volts AC, allowing the use of relatively small wires from the

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top of the tower to the battery control room. In the control room, the wiring goes through a transformer, which transforms the voltage down to 24 volts AC. From the transformer, the AC electricity is converted to DC, regulated through the Whisper's controller and stored in the battery bank. When the battery is full and the wind is still blowing, excess electricity is diverted to an electric water heater that supplements their propane-fired domestic water heater.

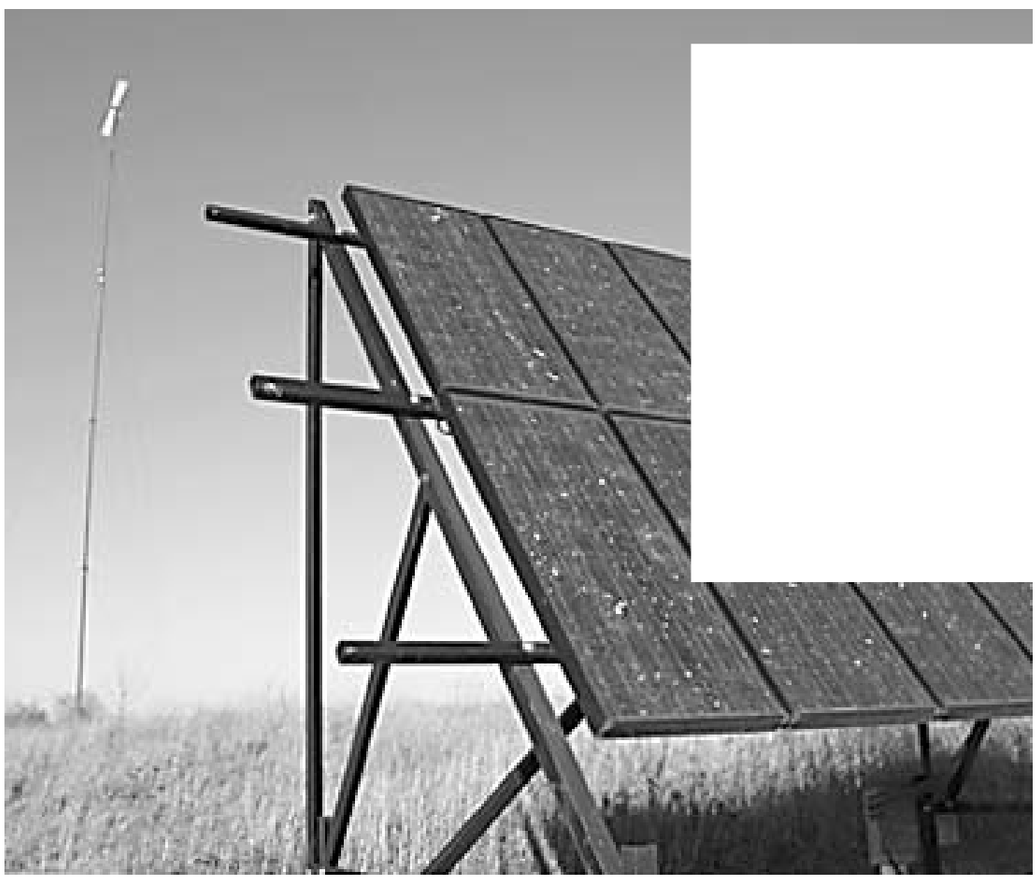
Once all the controls, monitoring equipment and inverters were installed, Cheryl and Bob's battery room began to look like an electrical substation control room. Their combined electrical and trouble-shooting skills improved greatly in very short order.

Bob jokes, "Be honest. Being your own utility company is a continuous job and not for the faint of heart. Periodic maintenance isn't particularly demanding. Watering the batteries, keeping connections clean and tight, brushing snow off the PV panels, and once a year lowering the tower and checking the wind machine is about it. The more demanding part is monitoring the system and diagnosing problems. Usually things break just when you need them the most."

Asked if they have any regrets, Bob responded, "Despite the uncertainties of changing technology, the quirks of the marketplace and corporate evolution, we find living with this energy to be stimulating and tremendously rewarding." Another satisfied owner-operated utility!

When the battery bank is fully charged, the home's second water heater (left) absorbs the heat produced by the excess wind energy. Also shown are the primary water heater, water softener, heating boiler and heating system expansion tank.

Since the Rezabek/Strous system was installed over ten years ago, the renewable energy marketplace has changed. Today's renewable energy technologies are better engineered. More reliable, easier to have installed and cost less.



(above) The controls and monitoring equipment make an impressive array in the basement battery room. Systems installed today can incorporate most of these components in a single factory-wired box which saves time and money and increases reliability.

(left) This array of photovoltaic panels supplies 1.2 kW of electric power to the Rezabek/Strous home.

Rezabek Case Study 5-04.qxp 5/24/2004 10:53 AM Page 3

Rezabek/Strous Home

Solar-Wind Hybrid System Flow Diagram

Wind turbine 240 VAC

Low-loss 240 VAC Line

240V & 24V Transformer and AC & DC Rectifier

Makes power compatible with batteries

Tapering Diversion Regulator

Monitors battery charge

24 VDC

Water heater

Excess power shunted to water heater

Solar PV panels
24 VDC PV controller

PV Controller

Monitors battery charge

24 VDC

Propane-powered Back-up Generator

Recharges low battery bank

Back-up Generator Transfer Switch

Activates back-up generator when batteries are low

Discharge Monitor

Measures battery level

Battery bank

Sun Frost 24 VDC Fridge

Standard 120 VAC House Current

24 VDC & 120 VAC Transformer

Inverters

24 VDC

Rezabek Case Study 5-04.qxp 5/24/2004 10:53 AM Page 4

Case Study Facts

Rezabek/Strous Solar-Wind Hybrid System

Date Completed: 1994

Personnel

Owners: Cheryl Rezabek and Bob Strous

Building contractor: Ed Hefty Construction, Oregon, WI

Renewable systems designers: PV system: Jim Kerbel, Photovoltaic Systems Co., Amherst, WI; Wind system: Mick Sagrillo, Sagrillo Power and Light, Forestville, WI

Renewable systems installers: PV system: Jim Kerbel, Photovoltaic Systems Co., Amherst, WI and Bob Ramlow, Artha Renewable Energy, Amherst, WI; Wind system: Jim Kerbel, Photovoltaic Systems Co., Amherst, WI and Bob Ramlow, Artha Renewable Energy, Amherst, WI

Building and Site

The Rezabek/Strous residence is located on an open hillside in a rural area near Brooklyn, WI. The site is unshaded and has an average wind speed of 10 mph–12 mph at 80 feet above ground. The 2,400-square-foot house was built in 1993 at a cost of $70 per square foot. It is oriented to the south, and has 2-foot roof overhangs and low-E glass windows. A liquid propane (LP) gas boiler provides in-floor radiant heat.

Other energy resources: LP gas for 5-kW generator, cooking stove, water heater, clothes drier and heating boiler

Annual energy usage: The home uses 1,000 gallons of LP gas per year for heat, hot water, cooking, clothes drying and 10 percent of its electricity. The home uses all the wind and solar electricity (1,575 kWh/year).

Equipment

The off-grid Rezabek/Strous wind-solar hybrid system produces 1,575 kWh per year (90 percent of the home's electricity) and includes the following components:

- 1.2-kW, fixed-rack-mounted Solarex modules: twenty 60-watt panels, array size 7'x17' or 119 ft^2
- 1-kW two-bladed Whisper 1000 wind turbine on a 80-foot tilt-up tower
- 24 VDC battery bank: original 24 deep-cycle batteries were replaced with sixteen L16 deep-cycle batteries in February 2002

System Costs and Benefits

ECONOMIC COSTS AND BENEFITS:

Solar system: $25,550 (a comparable system would cost about the same in 2003)

Wind system: $8,685 (a comparable system would cost almost twice as much in 2003)

Cost offset: $25,000 utility cost to bring power to the end of the driveway. Wiring to the house would have been additional.

Incentives: $2,500 grant from Wisconsin Power & Light (now Alliant Energy)

ENERGY AND ENVIRONMENTAL BENEFITS:

Power production: 1,575 kWh/yr

Fossil fuel load offset: one ton of coal

Pollution avoided per year:

- 10 lb. NO_x
- 17 lb. SO_2
- 3,780 lb. CO_2

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