Catch the wind

Co-op's giant windmills work with Mother Nature to provide power

By Steve Thompson
USDA Rural Development

Wind is free. So is the sun. So why aren't these free, non-polluting sources of energy ® in greater use as sources of electric power? Although cost and other considerations still limit the applicability of solar and wind power, utility cooperatives are using them more and more to fill power needs in important niche markets.

Harnessing the wind

Wind has been used as a power source for thousands of years. Perhaps its first use was powering ships and boats. Later, before the use of steam power, wind was used to power grain mills, oil presses, irrigation and drainage pumps in areas such as Holland, where climate or geography prevented the use of water power.

The South Dakota prairie provides an ideal location for these wind turbines, capable of generating a combined 2.6 megawatts. The immense size of the windmills (facing page) is evident from this perspective. When wind speeds become too high, wind tips are rotated to act as air brakes. Photo courtesy Basin Electric Power Cooperative.

Even today, across many remote areas of the United States, wind-powered pumps draw water from wells to fill livestock watering troughs. These fairly primitive wind turbines, little changed from 100 years ago, are symbolic of American agriculture, particularly in the prairie states where wind is abundant. Across much of the Great Plains, the annual average wind speed is about 13.4 miles per hour the point at which electrical power generation is considered economically feasible.

However, as a baseline (reliable) power source, wind has major drawbacks. First, it's fickle it doesn't always blow, and it sometimes blows when you don't need it. Just as important, areas with sufficient wind are often far from the potential market for the energy they can produce, and far from available transmission lines. For these and other reasons including a cost premium the use of wind to produce electricity is not widespread in the United States, either among electric cooperatives or other power utilities. Despite these obstacles, wind power is on the rise.

Basin Electric Power Cooperative, a large power generation co-op head-quartered in Bismarck, N.D., thought that wind power could serve as a supplemental source of "green" power for its operations. After looking at the costs and available incentives, the co-op calculated that with available new technology and the right location wind generation would not be as cheap as conventionally produced power, but would be "the most competitive of the renewable technologies," says Ron Rebenitsch, an engineer at Basin.

"We have an advantage in this respect over many other co-ops," Rebenitsch says, "because our unique status as a not-for-profit, but taxable, cooperative allows us to take advantage of the 1.7-cent kilowatt-hour tax credit available for wind energy. There are similar incentives offered to untaxed nonprofits, but they are renewed yearly, and there's always the chance that they won't be available in the future. You can't take that to the bank."

Stepping up to the plate

To help launch the wind project, one of Basin's largest members, East River Electric Cooperative, with members in South Dakota and western Minnesota, stepped up to the plate. It offered to take on the liability for the extra costs of one wind turbine.

"A general survey we took a few years ago indicated quite a bit of interest in green power among our members," says Scott Parsley, assistant general manager for member services at East River. "So in early 2000, we took another survey specifically to find out if enough of them would be willing to pay a premium for wind-generated power. We got an over-whelming [positive] response."

As the initial sponsoring member, East River put out a request for proposals and got eight responses from wind turbine vendors. Fortunately, the vendor with the best proposal was able to offer a project in a location that was able to obtain power transmission approval.

"The problem is that power transmission infrastructure is not being milt right now," says Rebenitsch. Current federal requirements make it risky for power firms to build transmission lines, because others have the right to apply to use unused capacity. If the builder is counting on that unused capacity for future needs, this can put a serious crimp in the business plan.

"Transmission approval is difficult to find nowadays, and not being able to guarantee it could stop most projects," Rebenitsch says.

The Prairie Winds Project, as it was named, found an excellent location in South Dakota, reasonably close to transmission lines and with an average wind velocity of more than 16 miles per hour. With the proposed equipment, the site promised to generate electricity at full capacity 32 percent of the time. "That's the best performance anyone's been able to achieve so far in the United States," says Parsley.

USDA provides financing

Financing for the $2.9 million cost of two turbines, and connecting lines to a power substation, was provided by USDA Rural Development's Rural Utilities Service (RUS). "We're glad to be a part of Prairie Winds," says RUS Administrator Hilda Legg. "It's a good example of how green technology can work for the individual members of power cooperatives." Legg says RUS encourages utility cooperatives looking to exploit wind and other green sources of power to apply for financial assistance.

Land was leased for the project, with royalties for the landowner that are expected to be in the range of $2,000 to $3,000 per turbine each year a welcome income supplement. Two turbines were installed: one is dedicated to production for East River, the other's output is available to a number of other Basin member distribution co-ops.

The wind turbines are built by Nordex, a Danish company with a reputation for quality and reliability. The turbines are immense the biggest available when they were built late last year. Their rotors measure 60 meters in diameter or almost 200 feet and they are mounted on tubular towers 200 feet tall. Each can produce 1.3 megawatts of power. They are twice as big as any other commercially produced wind turbines, which presented a problem for Rebenitsch.

Nordex projected a useful life span for the turbines of 20 years, based on the records of smaller models. But with no actual experience to back up that projection, Rebenitsch decided conservatism was the better part of valor. He initially set depreciation at 15 years, and all cost calculations were based on that assumption.

Prelude LLC EXHIBIT 25

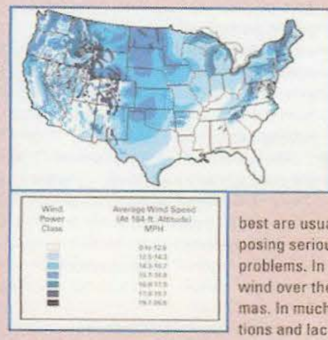
Basin Electric projected power generation costs at 5.5 to 6 cents per kilo-watt hour. After subtracting the tax credit and market-rate revenue, they were left with a shortfall. Part of the problem is that the area enjoys the lowest-cost power in the nation. Firm, or baseline, power is available for only 3 cents per kilowatt hour. Non-firm power, available intermittently, was estimated at about 1.8 cents. That amount, plus the 1.7 cent tax credit, gave the co-op 3.5 cents per kilowatt hour, leaving a deficit of 2.5 cents, or (adding a safe cushion) 3 cents.

The result is a $3 dollar premium for a 100-kilowatt-hour block of power These are marketed as sponsorships: each household pays $3 monthly. In return, 100 kilowatt-hours of their power consumption for the month is generated by wind.

U.S. wind power resources

Most of the 50 states have areas that might be suitable for wind power. This map shows wind resources in the United States categorized by wind power class, which is defined by a range of annual average wind speeds measured at 33 feet and 164 feet above the ground. Generally, wind power is greater at the higher altitude because of the "boundary layer" effect – the natural tendency of a moving fluid to move more slowly next to a surface. Buildings, vegetation, hills, and other features can also slow wind close to the ground.

The columns labeled "Wind Power" estimate the potential wind energy in watts available per square meter of land, making certain assumptions about turbine size and performance. Wind turbines are considered feasible in Wind Power Classes 4 through 7.



Other considerations make development of wind resources problematic in some areas. Although most of the western states and the Appalachian region have areas offering excellent wind characteristics, the best are usually located on mountain ridges, posing serious accessibility and transmission problems. In the Upper Midwest, exploiting the wind over the Great Lakes poses obvious dilemmas. In much of the Great Plains, remote locations and lack of nearby transmission capacity also limit exploitation. ■

Map courtesy U.S. Department of Energy

Isolated Navajos tap solar power

Though the vast majority of rural Americans have been supplied with electric power for decades, a small minority still don't have access. This is mostly because they live in areas too remote and sparsely settled (as seen below) to make power transmission to their homes practical. Some of these areas belong to the Navajo Nation, on a vast reservation taking up parts of Colorado, New Mexico, Arizona and Utah.

Traditionally, Navajos have lived in widely scattered dwellings. While many today have moved to towns and villages, a large number of families and individuals still live far from each other and from paved roads. With power transmission lines costing an average $30,000 a mile, many of these households make do without any kind of electric power. A few use gasoline generators to power lights and small appliances.

So in 1994, when the Department of Energy offered a grant through the Western Power Administration to provide a small number of individual solar power generators, the Navajo Tribal Utility Association (NTUA) took the chance to offer electricity to households that had never had it before.

The grant was enough to pay for the purchase and maintenance of 40 small photovoltaic generators, each producing only 200 watts. This is only about enough to power a light bulb or two and a small transistor radio – not much more. Even so, a number of isolated homesteads found it worth the $40 monthly fee.

When it comes to solar power, the Navajos have an advantage because the vast majority of their days have sunshine – often without a cloud in the sky.

The program was successful enough that in 1999, the management board of the utility decided to authorize the purchase of 100 new, larger units, using $1 million of the co-op's own money. The tribal utility co-op purchased 100 units built by Kyocera, each producing 640 watts – much more than the previous units, but still not a lot of power by the standards of most American households.

Simple devices

The units are quite simple. A horizontal rectangular metal frame provides a base on which are mounted a panel of photovoltaic cells, a box holding eight, 12-volt lead- acid batteries, and another box holding a controller and an inverter. The later device converts the low-voltage direct current put out by the batteries into 120-volt alternating house current. The photovoltaic (solar) cells are mounted so as to face the sun in the middle of the day. They convert sunlight directly into electricity.

Photos courtesy Navajo Tribal Utility Association

Blades the size of jet wings

The groundbreaking for the turbine installations took place last Sept. 7, and both turbines were dedicated less than two months later. The construction went quickly because, except for the foundations, the parts, including the towers, were prefabricated. Says Parsley, "It would have taken less time than that, except that the wind slowed things down." On some days, high winds made it unsafe to operate the huge cranes lifting the tower sections, generator assembly, and fiberglass turbine blades each the length of a Boeing 747 wing into place.

The turbines are far more sophisticated than the typical prairie water pump. The mechanicals, including the generator and transmission, are hidden in a sleek fiberglass housing, which pivots on the top of a giant steel tube making up the tower. Unlike the old prairie "windmills," they do not use a weathervane like tail to turn them into the wind. Instead, hydraulics turn the turbine assembly, obeying a computer using information from a small wind vane mounted on top of the housing.

The same computer also takes constant note of the current wind speed, from an anemometer mounted next to the wind vane. It adjusts the angle of attack of the rotor blades for efficiency and to keep the speed of rotation within safe limits. If rotational speed goes higher than 19.2 rpm, centrifugally operated airbrakes automatically deploy from the ends of the rotor blades. Should they malfunction or prove insufficient to slow the rotor in high winds, a large disk brake mounted on the generator shaft can smoothly bring the turbine to a halt.

The turbines are remotely monitored using telemetry that transmits wind speed, temperature, hydraulic pressures, rotational speed, and other important data, allowing their operators to keep constant tabs on them without being on site. They are built to survive wind speeds of up to 145 miles per hour with the rotor stationary. The windmills begin producing electricity at 6 miles per hour and reach their peak output at 33.5 mph.

Prelude LLC EXHIBIT 25

which is collected and stored in the batteries.

The generators are limited in size not only by cost – photovoltaic cells are very expensive for their power output – but by the need for portability. The roads over which they must be hauled are rudimentary, and they are loaded on 16-foot trailers towed by four-wheel drive vehicles for the trips to the installation sites.

Despite these challenges, the new generators were up and running by 2001.

NTUA charges a $95 per month flat fee for the use of each 640-watt solar generator. So far, they have proven reliable, much like their smaller predecessors, of which about 24 are still in use (the company that made the smaller units has gone out of business, and parts are no longer available).

However, not all customers are happy with them. Some complain of the cost — most of the users are on public assistance, and for them $95 a month is a steep price to pay. Says Paul Denetclaw, who runs the program, "Some folks really like it, some think it's too expensive. The ones that seem to appreciate it the most are those who had a generator before, and had to keep it gassed up and serviced."

Denetclaw says that young people who have lived where electricity is available are often disappointed when they find that the generator can't supply enough power for all the appliances and electronics they are used to.

Overload problems

The biggest problem with the units, says Denetclaw, is that users sometimes overload them. When this happens, the batteries discharge faster than they can be recharged by the photocells. Most service calls center around this issue, even though the users are supplied with an indoor monitor that reveals the state of charge. "All we can do in those cases is turn off the power and let the batteries charge for a few days," he says.

Another problem stems from the use of an inverter that supplies alternating current in square waves, rather than the rounded, sine waves produced by conventional generating equipment. Some modern electronic gadgets don't function well on this kind of current. Light bulbs, on the other hand, take either type current. NTUA provides customers with information on models of appliances that operate well on the power from the solar units.

Despite the inherent limitations of the solar generators, NTUA believes that their advantages outweigh the problems in providing a necessary service for people who otherwise couldn't have electric power. USDA Rural Utilities Service encouraged the co-op to apply for a low-interest loan to pay for more of the 640-watt generators and maintain them for 15 years. On Dec. 21, 2001, RUS approved a loan of $4.8 million. Initially, NTUA plans to draw on $1.6 million to put new generators into service. ■

—*Steve Thompson*

While it's too early to declare total success for the project, both Parsley and Rebenitsch are optimistic. So far the turbines have performed at, or above, expectations. "It's been an exciting project, and a lot of fun," Parsley says. "One thing I enjoy is people's reactions when they first see the turbines. Often they don't realize the size of these things until they see them in person." Meanwhile, wind technology is marching on. Nordex is now taking orders for a monster wind generator with twice the power output of each of the Prairie Winds turbines. Its rotor diameter will be half again as big: 300 feet.

Other wind turbine manufacturers are offering similar products. Increases in economies of scale and other developments in this rapidly advancing field promise that costs will continue to decline, albeit gradually. Add the enthusiasm of many power customers and the Bush administration's policy of encouraging the use of renewable energy sources, and it seems that wind turbines may be an increasingly common sight in much of America.

March/April Table of Contents

HOME MAGAZINE SITE INDEX E-MAIL

Prelude LLC EXHIBIT 25