Windpower Can Save Your Energy Dollars

By Herschel H. Klueter

Once almost every farm in the Midwest and other parts of the United States had at least one windmill. Many had several. Between 1840 and 1940, an estimated 6.5 million windmills were sold in this country. They were used primarily to pump water for livestock and the home.

The windmill provided water to cattle that grazed the Plains and eventually led to the settling of the West.

Many of these "water pumps" still operate in remote areas on large ranches.

A second major use of the windmill was for generating electricity.

The electricity generated was stored in batteries and used in the home for lights, and a few small electrical appliances and motors. Simple windmill systems proved adequate for the required tasks, until the availability of central station power distribution by public utilities to rural areas in the 1930's and 1940's.

This made possible an abundant, reliable, and inexpensive supply of electricity. One requirement for converting to a utility was that there be no other power sources to compete with them. So for the most part the windmills were abandoned and left to rust.

The current energy shortage has opened a renewed interest in wind as a source of energy. Considerable effort has been expended by the Department of Energy (DOE), the U.S. Department of Agriculture (USDA), other agencies and private companies to develop and evaluate the technical and economic feasibility of wind as a source of energy. USDA has been given the task of assessing the wind energy potential in agriculture and developing techniques for using that energy.

Thrust of the initial work was to identify areas in agriculture where wind energy could most likely have a sizable impact on energy use. Four criteria were

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used to evaluate possible uses of wind energy.

These were:

- Is it a major use of energy?
- Is it used over a considerable portion of the year?
- Does it have the capability of inherent energy storage?
- Is it located in an area of reasonably high wind?

Three areas stand out as likely for wind energy use: irrigation, heating of buildings, and product processing and storage. It is unlikely that any one of these uses will make the wind turbine economically feasible. It will take several uses in sequence throughout the year. One such sequence might be irrigation, in spring and summer, crop drying in fall, and either residential or livestock heating in winter.

Electrical Grid Tie-In

One difficulty with multiple use of a wind turbine is that all the loads will not likely be the same. Irrigation takes considerably more energy than either crop drying or heating. Typical irrigation requirements are 40 to 100 kilowatts (kW), while heating and drying run 10 to 40 kW. This problem can be overcome by having an electrical output that ties into the electric utility power system. Any excess electricity produced by the wind turbine can be fed back into the electrical grid.

An extra benefit from using windpower with the electrical grid can be achieved if storage is available. This could provide some load management of the electrical demand. An example is a dairy operation with both an ice builder (for milk cooling) and hot water storage. When wind energy is adequate, storage of energy for three days use could be provided.

With this storage capability, even if the wind did not blow, the refrigeration and heating could be turned on during nonpeak load periods between midnight and 6 a.m. to provide enough ice and hot water for that day. The refrigeration-heating system could then be locked out for the peak demand period for the utility. The wind turbine could also supply electricity back to the grid at peak demand. Numerous other possibilities exist if the right wind turbine can be found.

There are two basic classifications of wind turbines. These are horizontal axis and vertical axis. The difference is in the position of the rotating axis. There are various configurations within both of these.

1) **Horizontal Axis.** Among the horizontal axis wind turbines frequently seen are the American multiblade, the multibladed bicycle, the 4-bladed Dutch and the high speed 2 and 3 blade propeller type.

Of these the 2 to 3 blade high speed is the most appropriate for modern use as a wind turbine. It has high efficiency in high wind regions where the high energy is available. Sizes of rated output from less than a kilowatt to 2.5 megawatts are being made and tested. This type turbine will probably provide the major portion of the windpower produced.

The other types of horizontal axis turbines may have some applications, but they will be limited to small size and relatively low wind areas.

2) **Vertical Axis.** The two types of vertical axis wind turbines are the Darrieus and Savonius, both named after their inventors.

The Darrieus is a 2 or 3 bladed low-solidity, high-speed turbine that looks like an egg beater. It has characteristics similar to the high-speed horizontal axis turbine with two major exceptions. The Darrieus is not self starting; it requires some type of motor to start it. However, it is somewhat less complicated, since the turbine itself is a major part of the tower. Turbines up to 500 kW are under development and test.

A variation of the Darrieus is the Giromill, which has extra gearing to keep the turbine blade at maximum angle of attack (power) during the power part of the rotation. The blade is then turned to provide least resistance for the return.

Both the Darrieus and the Giromill offer good possibilities for considerable use in generating wind power. On the other hand, the Savonius has severe limitations in both size and the windspeed in which it will operate.

Energy output from these major types of wind turbines is rotary, which can be converted to mechanical, or either AC or DC Electric. A number of companies are currently developing and producing a variety of wind machines. Check your local public library for a classified directory listing wind generator manufacturers.

Availability of Wind

One of the major criteria for having a feasible wind energy system is the amount and distribution of the wind. The wind varies extremely from day to day and even from moment to moment. This is true for both direction and speed.

An attempt has been made to measure available wind over the United States. Most of the information was obtained from weather data recorded at various airports, and is quite general.

An open rounded hill usually provides a good location for a wind turbine, while buildings or trees tend to reduce windspeed as well as make the wind more turbulent. When considering an extensive wind

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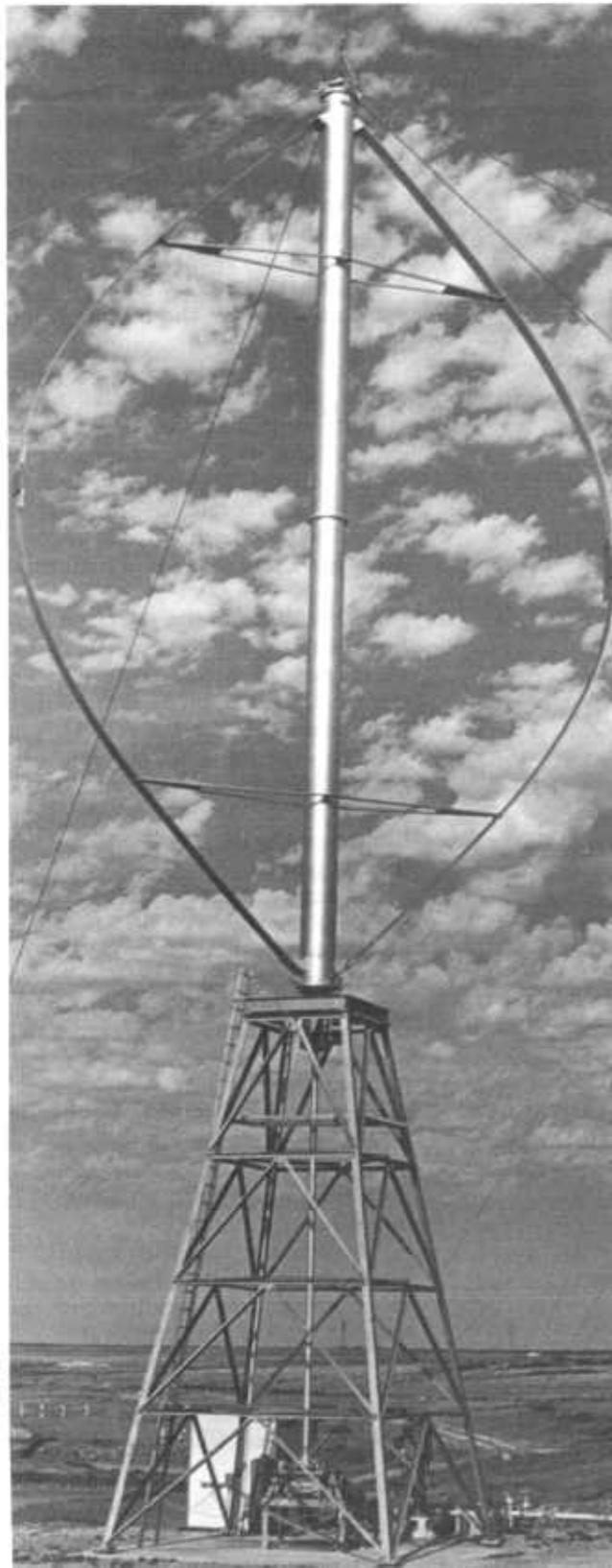
Rising 57 feet above a 30-foot steel tower, this vertical axis "Darrieus" wind turbine can harness at least 30 percent of the enormous energy carried by the wind. This one is at Bushland, Tex.



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energy program, you should find out if your specific location has sufficient winds to make a wind turbine feasible.

Things to consider in evaluating the feasibility of wind energy on an individual basis can be grouped into four general areas: Do I have enough wind energy? Is my application reasonable? Are the necessary items available to put the system together? Are the financial considerations such that it will be economical? Each will be discussed in some detail.

Wind Availability. This topic has already been considered, but on an individual basis it might be checked more closely to answer such questions as: Do I have enough wind? How does it vary annually, seasonally, daily? How gusty is it?

These questions can best be answered by checking records of nearby weather stations and by measuring the wind in your own location. Wind measuring instruments can sometimes be borrowed from State energy offices or rented from dealers of wind energy systems.

Other questions to consider are: Can I locate the wind turbine so it will be reasonably close to the energy use? Will it interfere with other operations on the farm? Will it be too noisy or unsightly? Will it create a safety hazard? When these and other pertinent questions have been answered favorably the next area can be considered, that of application.

Application. The major consideration here is, can I use the major portion of the wind turbine energy output directly in some application? If not, can I provide storage for the energy, or can it be fed back into the utility grid? Before it can be connected to the utility it will require clearance from the power company.

An example of a good application is on a dairy farm for cooling milk and heating water. This operation is done every day of the year with a fairly constant daily demand. Energy supplied to the compressor can provide both ice and "warm" water, at a very efficient level. That is, for a watt of power put into the compressor motor and taking into account the coefficient of performance of the compressor, you can obtain two or more watts of cooling for ice and three or more watts for heating water.

In contrast, the energy required for milking is not a good use of wind energy. Very little energy can be stored in a vacuum system, and the energy need is essential at the time of milking. If the wind is not available at that time the wind system would be useless. On the other hand, if the energy could be delivered to the electric grid and drawn when needed, this arrangement would be quite satisfactory.

Each specific application on the farm should be evaluated in a similar way. Once all applications are considered, the total wind energy system can be developed.

System Availability. A main deterrent to using wind energy on farms is the lack of large, reliable systems that can be purchased and installed. And like any other farm operation it is important to think in terms of a complete system.

While great strides have been made in the last few years to develop wind systems, the more reliable ones at this time are limited to a rated output of 2 kilowatts or less. Larger ones are being developed but are mostly in the prototype stage. No long term durability studies have been conducted.

This doesn't mean wind systems should not be considered. On the contrary, there is a great opportunity and need for innovative farmers to become involved.

Individual companies, the American Wind Energy Association, and government agencies are anxious to cooperate any way they can in the development of wind energy systems. Companies involved in wind systems need the input of the farm user to purchase, test, and provide feedback to the wind industry.

Individuals should investigate a number of possibilities before making any major decision. The power company representative should also be contacted in the early planning stage, for helpful suggestions.

Financial Aspects. The final area to consider in evaluating the feasibility of a wind energy system for your application is financial. Such questions as: Is the money available at a reasonable interest? Can I apply this to a Federal or State tax credit? Do other tax considerations apply? How much maintenance will be required and how long will the system last? What will alternate energy cost 10 or 20 years from now?

It is difficult to predict how long the systems will last, or how much fuel or electricity may cost 10 or 20 years from now. These questions however, must be addressed with the best knowledge available. Risks are sizable but at the same time the financial gain may also be large.

The Future

Fifty years ago nearly all farms had at least one windmill. Fifty years from now it is likely that many farmers will again have one or more windmills. The size and type of windmill will be greatly different.

The modern windmill of the present and future will be much larger — some may be as large as sev-

eral hundred kilowatts, but more likely 20 to 100 kW. They will also be used for a wider variety of uses. Certainly a greater portion of the available energy will be used.

It is conceivable that some electric cooperatives and smaller power companies may generate a majority of their power through windmills located on individual farms or on wind energy farms developed for that purpose.

Even so, it will take more than one energy source to satisfy all the energy needs. The windmill will fit in with other energy sources. Solar has more potential for summer, while wind is usually greater and more consistent in winter. Also, biomass — either from crop residue or animal waste — can be used as a backup fuel. Where energy storage is available, a number of energy systems will likely provide the necessary energy supplies.

The future for wind energy looks bright. It will be used to power irrigation systems, heat and cool buildings, animals and crops, and to process and preserve products, for the farm and the consumer. Wind will contribute greatly to maintaining the quality of farm products at a reasonable cost.

Further Reading:

Wind Energy Information Directory, Solar Energy Research Institute, #061-000-00350-9, for sale from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. $1.75.

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Fifty years ago nearly all farms had at least one windmill, like one in foreground. It was primarily used to pump water. Fifty years from now farmers may again have windmills, but more like one in background. It is a wind turbine generator that supplies part of electric power for people of Clayton, N. Mex.