WINDS OF CHANGE

BY ANNE BROWNING

"Wherever there is a high standard of living, there is also a low standard and the cost of these high standards, is usually paid for by future generations."

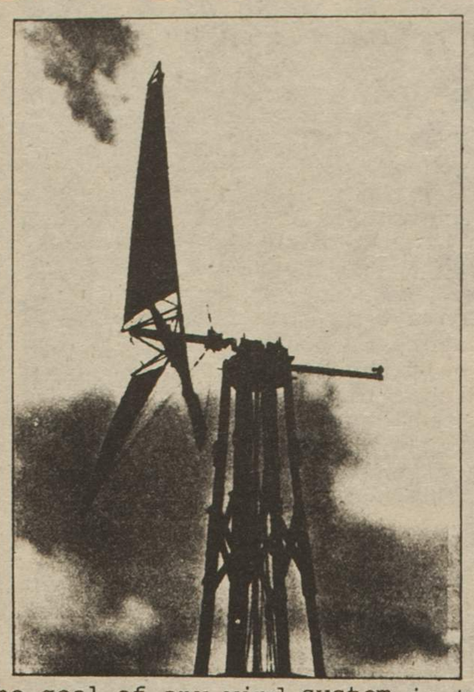
Whenever I think of windmills I get two images. The first is the teetering, ivy-entwined old farm windmill visible at about two mile intervals anywhere in Kansas. The second is one of those fifty-foot monsers with twenty-five-foot propellers which I saw in a Walt Disney movie about Holland. These images remain quite appealing to me, but I now realize how ridiculously removed they are from the modern intermediate and advanced wind technologies of today.

The development of automobile electrical systems and aeronautical propeller design were important factors leading to practical design of wind-driven generators--the first form of free private electrical power generation. In the United States windmills sprang up on farms everywhere in the 20's and 30's, until the Rural Electrification Agency (REA) began to provide more convenient and cheaper sources of large amounts of electricity. With currently growing recognition of the folly of dependence upon nonrenewable energy resources and their accompanying pollution, monopolistic control, and skyrocketing prices, more people are turning to cheap, clean and eternal sources of energy. They are finding the wind a beautiful alternative.

FUNDAMENTALS:

Unlike the old Dutch windmill of my memory, the windmills of today don't use the wind directly for mechanical energy such as pumping water or grinding grain; rather, they convert the wind's energy into electricity. A complete wind system is composed of :

1) a tower to support the wind generator
2) devices to regulate generator voltage
3) propeller and hub system
4) tail vane
5) storage system from which to draw power on windless days
6) an inverter, when necessary, to convert from stored direct current(DC) into alternating current (AC).

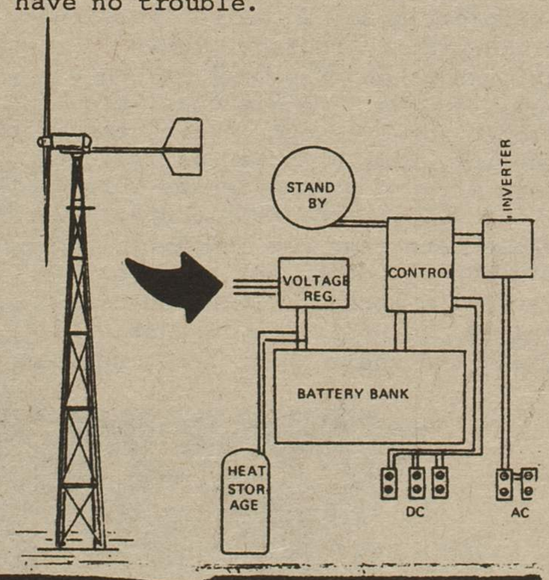


The goal of any wind system is to produce a kilowat hour at the lowest cost. However, no system can alter the fact of life that winds are an "intermittent source" of energy. The basic law of actual wind energy production is known as the Cube Law, which states that the wind power available is proportional to the cube of the windspeed; that is, if you double the windspeed, you will get 2^3 or 8 times as much power.

The amount of energy captured by the windmill of course depends on the amount of wind intercepted, or the disc area swept by the blades. This leads to a second basic wind energy law regarding the relationship between the power produced and the propeller diameter: when you double the diameter of the propeller the output will increase by a factor of four.

CHOOSING A SITE:

In order to find out how many kilowatt hours per month you will be able to produce, you first must determine the average yearly wind speed of the proposed site. The National Weather Bureau records center (U.S. Weather Bureau, Federal Building, Asheville, N.C. 28801) will probably have some statistics for your area or you may purchase your own anemometer (wind gauge.) In planning for your storage and back up systems, you will want to know the average longest periods of no wind and shortest periods of some wind. Generally, if you find over a 10 mph wind average on a norm of 2 or 3 days per week, you probably have an adequate wind power site. Needless to say, prospective windmill builders in Kansas should have no trouble.



The size of your wind system will be figured in realtion to the relative wind velocity of the region. Six mph is the lowest practical speed and 12-25 mph is considered the highest range. There are two types of winds during a month; first the "prevalent winds" from 5-13 mph, and second the "energy winds" ranging from 13-23 mph. Although the prevalent winds occur two and one-half times as often as the energy winds, the energy winds will probably produce about three-fourths of your power because the energy varies with the cube of velocity (Cube Law again.)

Your tower must be very strong to support the generator assembly under the strongest of winds (most commercial towers will withstand 140 mph.) The best location is as high as is economically feasible to reach free-flowing, unobstructed air currents, such as 15 to 20 feet over all obstacles within a 500-foot radius. This is due to the disturbing influence of surrounding objects causing the air to whirl and have an irregular flow. A nearby hill or high ridge will similarly cause turbulence because winds blow parallel to the ground, not at right angles to gravity.

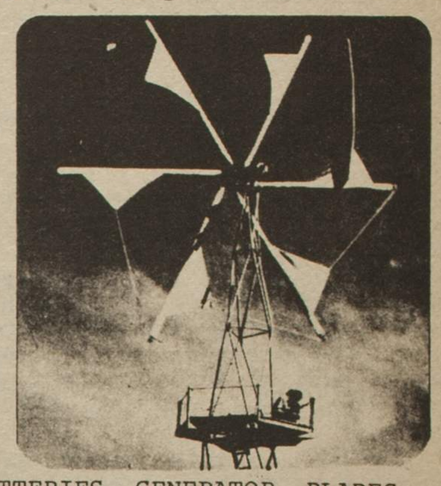
Nominal Output Rating of Generator in Watts	Average Monthly Wind Speed in mph					
	6	8	10	12	14	16
50	1.4	3	5	7	9	10
100	3	5	8	11	13	15
250	6	12	18	24	29	32
500	12	24	35	46	55	62
1,000	22	45	65	86	104	120
2,000	40	80	120	160	200	235
4,000	75	150	230	310	390	460
6,000	115	230	350	470	590	710
8,000	150	300	450	600	750	900
10,000	185	370	550	730	910	1090
12,000	215	430	650	870	1090	1310

AVERAGE MONTHLY OUTPUT IN KILOWATT-HOURS

CAPACITIES

To choose an effective wind system, keeping your storage costs at a minimum, you will want to determine how much power you will practically have at your disposal. The following three steps should give you an idea of your wind plant's potential.

1) Locate on the chart both your average wind speed and the generator rating of the system in question and you will find the expected monthly output. Divide by 30 and you will get a figure for the number of watt hours per day available for your use. 2) Find the capacity in Kilowatt hours of the battery system you will be using, by multiplying the amps times the volts, which will give you the number of watt hours. Divide by 1,000 to determine the kilowatt hours capacity. 3) From here you can determine the number of days with no wind on which you could operate from storage, by dividing the watt hours capacity of your battery (step 2) by the estimated watt hours per day you will use (step 1).



BATTERIES, GENERATOR, BLADES

Wind system batteries must be capable of storing power for long windless periods at a moderate cost. The best battery at present is probably the lead acid battery which is designed for repeated cycling from full charge to full discharge for a period of many years. Proper care of the battery can extend its life remarkably.

After you have determined your daily electrical needs and the size of battery or storage system you will use, you may determine the necessary size of your generator or alternator. Conventional alternators are not practical as they are designed for high rotational speeds (1800-3600 rpm or reveloutions per minute,) whereas wind driven gnerators require a low cut-in speed. These direct drive or low gear ratio type generators have the additional benefits of materials efficiency and minimum wear on the machine.

The modern wind system will use 2or 3 long slender blades which are designed to operate at a high "tip speed ratio" - the ratio of the propeller tip speed to the wind velocity. A higher tip speed means higher rpm for a given wind speed and consequently more power output. The main advantage of a propeller as opposed to multi-blade design is that the propellers will rotate 5 to 10 times faster. The three bladed props have been found to more easily overcome difficulties in low winds and to more easily orient to changes in wind direction.

These are a few of the many factors to consider in putting together a wind system suitable to your needs. For more information, see The Energy Primer by Portola Institute in your bookstore or write 558 Sante Cruz Ave., Menlo Park, Ca.