NEED FOR A REGIONAL WIND SURVEY

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The economically favorable utilization of wind power on at least a modest scale will most likely occur in those regions of the U.S. where the greatest potential exists and where the intermittent nature of the wind speeds is small. Golding and others (ref. 1) have emphasized the need for accurate measurements designed specifically for the purpose of estimating wind energies, but in the U.S. only a small amount of work has been done. Thomas (ref. 2) indicated that the Southern Great Plains is a region over which wind speeds are significantly greater than in almost any other part of the nation, a fact that is common knowledge to residents of the area. The area is large, flat, and accessible (both financially and physically).

The general wind characteristics as indicated by data from the National Weather Service are as follows:

(1) The average wind speed is high (table 1). The 31-year mean for Amarillo, Texas, is 13.7 mph (anemometer height is 23 ft.), and the wind speed is greater than 15 mph 35 percent of the time.

(2) The average wind speeds are consistently high throughout the year with the strongest winds in the spring.

(3) The wind occurs both night and day with a small diurnal variation. The low and high averages by time of day for any month differ by approximately 3 mph from the average value during windy months.

(4) The duration of calm periods (zero speeds) is short. For Amarillo, Texas, from 1968 to 1972 there were only two, 9-hour calm periods and six, 6-hour calm periods. The lowest daily average for the 5-year period was a speed of 4.3 mph, which was on one of the days with a 9-hour calm period. The wind speed frequency curves (fig. 1 and 2) show that over 90 percent of the time the wind speed is greater than 5 mph. In fact for 1970-72 (3-hr observations) the wind was 9 mph, or greater, approximately 80 percent of the time.

(5) High wind speeds are also common (table 2) with gusts of over

80 mph. During the spring of 1973 gusts to 100 mph caused extensive damage in the area.

Preliminary calculations made from National Weather Service data (Amarillo, Texas) give an indication of the energy in the wind, 153 to 212 kW-hr/(ft^2- yr) for 1970 to 1972 (table 3). Comparable results were obtained for other years (fig. 3 and 4, data from the 1950's), and a somewhat smaller value was obtained for Oklahoma (ref. 3).

There are several limitations that must be recognized in using weather station data to evaluate the wind power potential. Wind speed is known to vary with height. Obstructions are sometimes found close enough to anemometers to affect their readings. And the method of taking an average reading may indicate too little energy. Relatively small increments in wind speed values lead to large differences in the calculated values of the energy. For example, systematic errors of 2 and 4 mph give calculated energy differences of approximately 32 and 69 percent respectively. (See fig. 3 and 4.) Such differences in the available energy magnitude may well determine whether wind energy capture is economically feasible.

We are beginning a wind energy survey based on the data compiled at the 10 National Weather Service Stations within 275 miles of Amarillo (fig. 5). The wind survey will provide data from which the wind energy potential can be estimated for an integrated network. The type of information calculated will be the statistical characteristics of the wind and the time correlations between the stations. As stated earlier, this area is large (area of the circle is greater than the combined areas of New England, New York, and Pennsylvania), essentially flat, and accessible; and it encompasses the high wind region.

We are also planning to collect data at sites in the immediate vicinity of Amarillo. These data could then be correlated with the data from the National Weather Service.

REFERENCES

1. Proceedings of the United Nations Conference on New Sources of Energy, Rome, Aug. 21-31, 1961 vol. 7, Wind Power. United Nations, 1964.

2. Thomas, Percy H.: Electric Power from the Wind. Federal Power Commission, Washington, D.C., 1945.

3. Energy Storage..Key to Our Economic Future, Oklahoma State University, School of Electrical Engineering.

DISCUSSION

Q: When you have a Weather Bureau Station a different height than you like, how feasible is it by relatively short-term measurements at different heights to get the effect?

A: He wants to know if you have Weather Bureau data at a certain height then how do you get data for different heights. There have been some tables put out on the difference in height. Say you took wind speed measurements at 10 feet. Then, what can you estimate the wind speed to be at 100 feet. About three different tables have been published, and they really don't agree. I talked to a friend of mine who is in meteorology, and he said, for example, between 10 and 100 feet just add 60 percent. Now, I don't know how accurate that is.

Q: My question was about the measurement. Can you do better by particular tables?

A: I'm not sure actually. Once you get a correlation between heights, your Weather Bureau data will give you a good idea of the wind energy potential in that region.

Q: I have a question and a comment. I believe that in the Western part of your region there is quite a bit of high ground there, and, with the speed-up factors on high terrain the British investigations show, I wondered if you were going to get really much in that area.

The second comment: In the Texas area near Dallas there is a high TV tower that has been instrumented. You might do some extrapolations from that as it is one of the tallest instrumented towers on the continent.

A: Yes, I have seen some data from that tower. It is in a region of low wind down there. There is a range of mountains between us and Albuquerque, and we don't expect much wind from that region. In other words, it's only when you get out on the high plain that you get high wind velocity essentially the year round.

Q: I was wondering whether you people had done any work on instrumentation that would measure wind energy directly. There has been some suggestion that the anemometer that measures velocity is not what you're interested in. What you're really interested in is v^3.

A: Some people in England measure wind energy directly.

Q: Is that going to be used?

A-1: We don't know yet. Probably.

A-2: Just to add to your reply, the type of the anemometer that the French used for the wind service during the 1940's and 1950's was an integrated type of meter. It gave out kilometers per meter squared. This has certain characteristics itself. It acts as an energy machine so it doesn't necessarily have the same characteristics. There is a mass of data for France in kilowatt hours.

TABLE 1

MEAN WIND SPEED FOR AMARILLO, TEXAS (1942-72)

Jan.	13.2	July	12.4
Feb.	14.3	Aug.	11.9
Mar.	14.5	Sept.	13.1
Apr.	15.4	Oct.	13.0
May	14.8	Nov. 13.2	13.2
June	14.4	Dec.	13.2

Average = 13.7 mph = 6.09 m/s = 21.9 km/hr

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TABLE 2

SPEED OF FASTEST MILE FOR AMARILLO, TEXAS

	mph	km/hr	(Number of Days 50 mph and above)
1968	50	80	2
1969	59	94	3
1970	59	94	2
1971	54	86	1
1972	64	102	2
1973	65	104	3

TABLE 3

ENERGY (kW-hr/m^2) IN THE WIND*

Month	1970	1971	1972
1	107	171	179
2	86	272	141
3	180	310	164
4	186	274	240
5	131	277	185
6	150	217	117
7	73	110	129
8	51	102	94
9	120	163	159
10	156	136	137
11	228	133	158
12	184	125	149
Totals (kW-hr/m^2-Yr)	1652	2290	1852
kW-hr/ft^2-Yr	153	212	172

*Values calculated from 3 hour observations of wind speeds, anemometer at 23 ft., from National Weather Service, Amarillo, Texas.

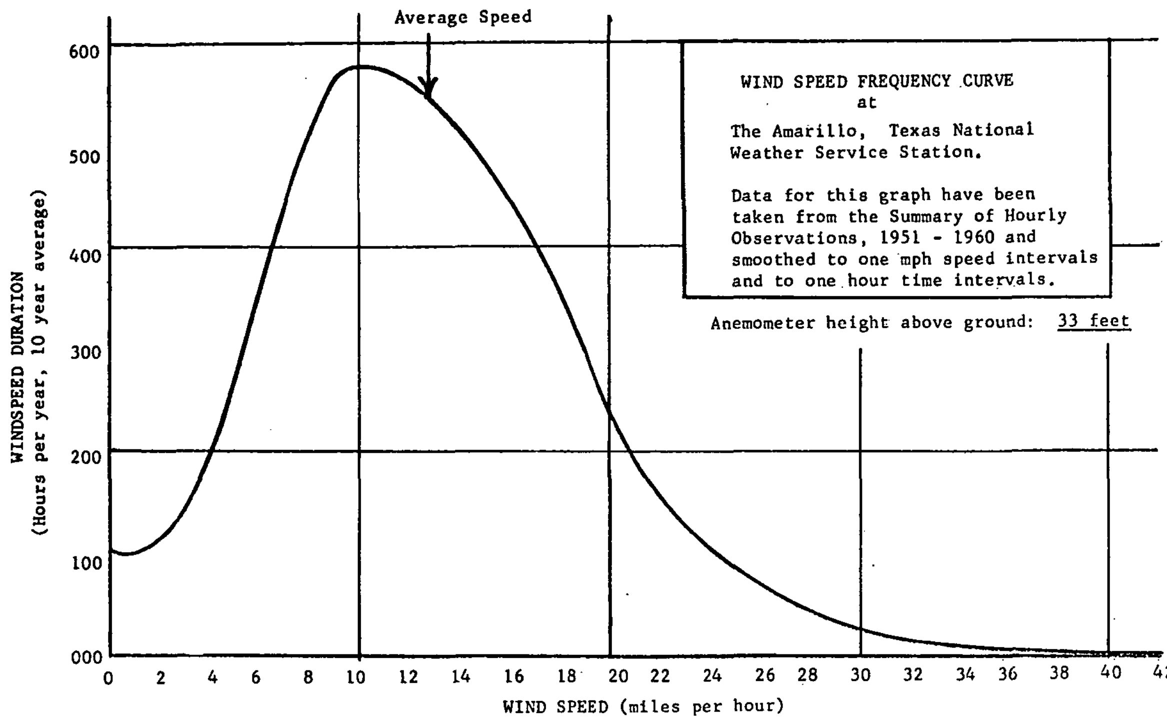

FIGURE 1.

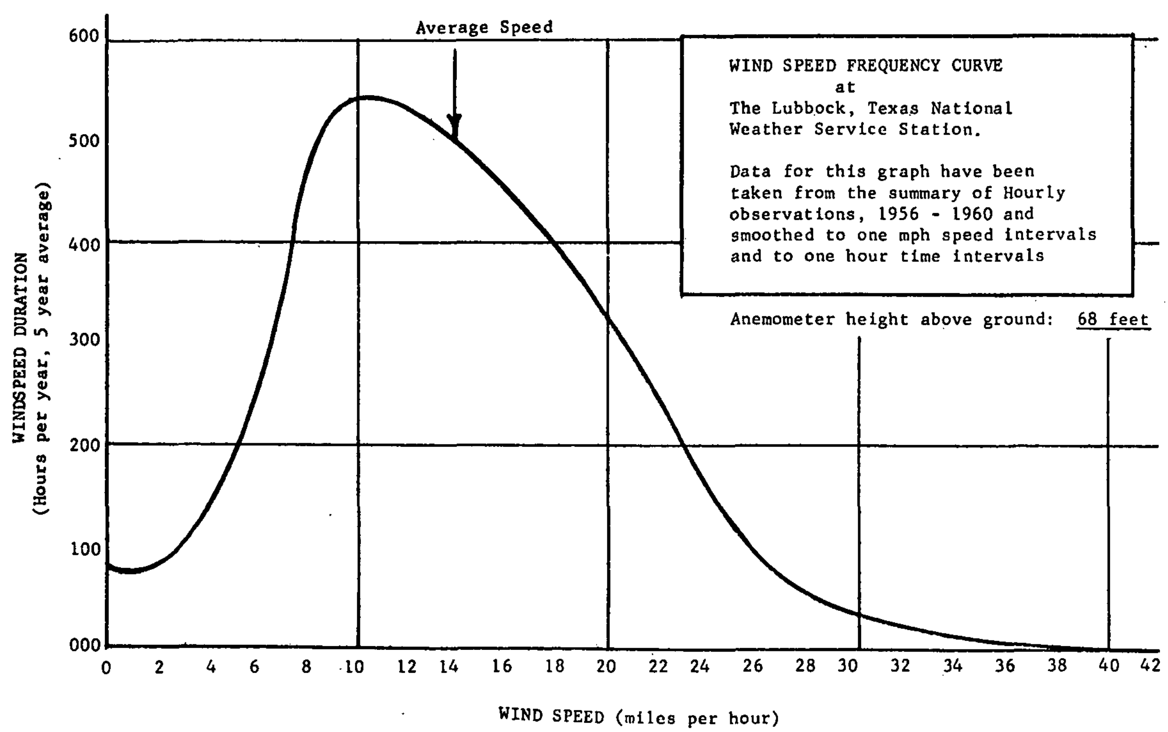

FIGURE 2.

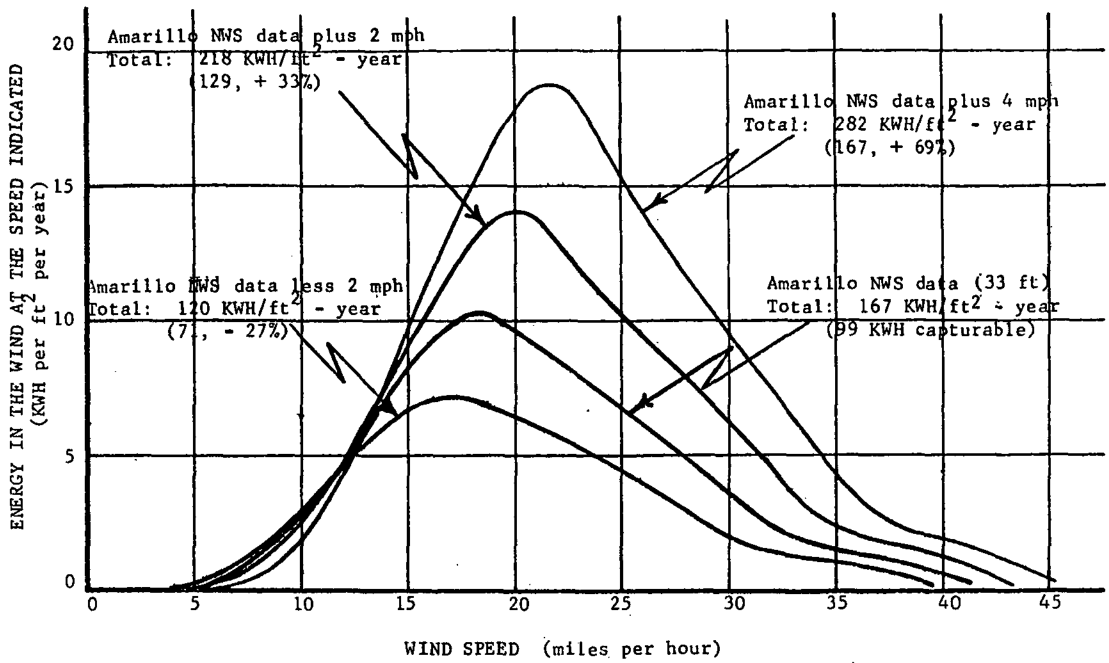

FIGURE 3.

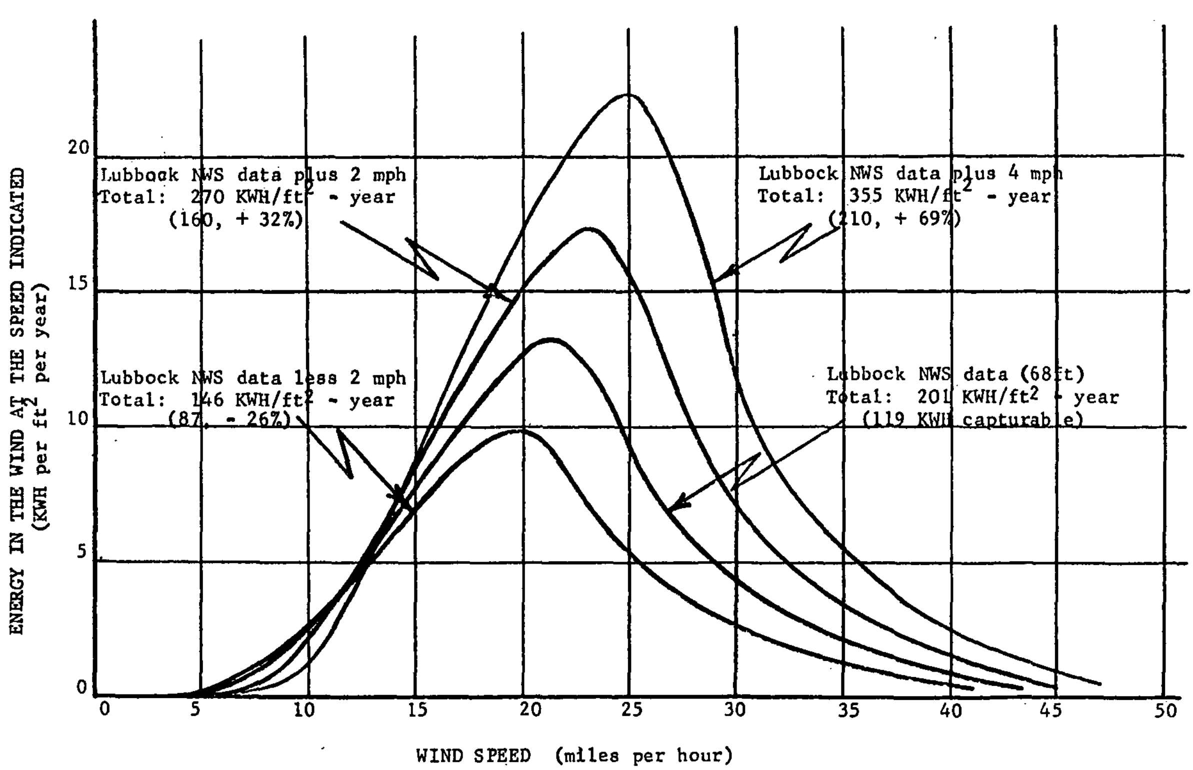

FIGURE 4.

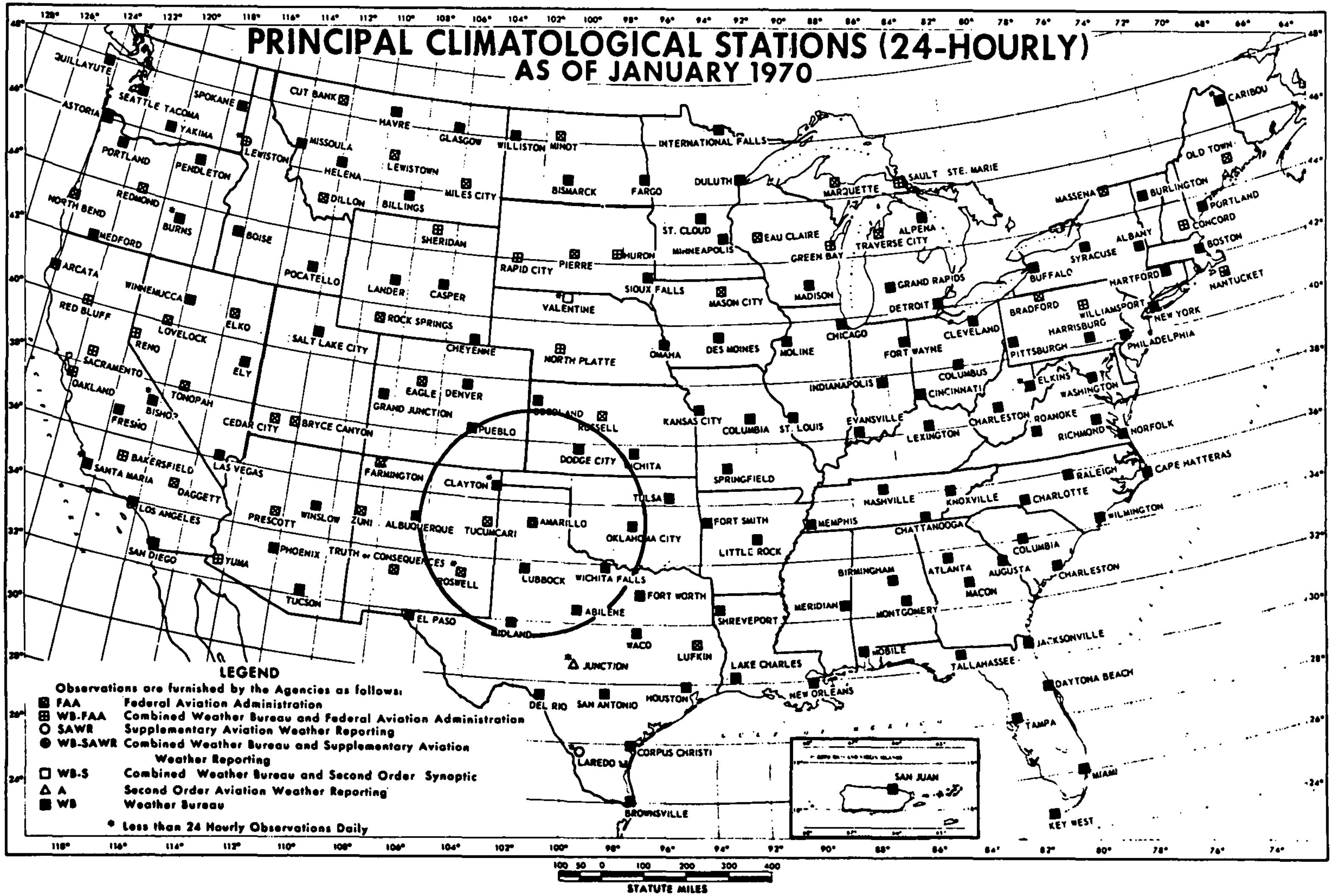

FIGURE 5. Map Taken From The National Climatic Center, NOAA, 1970.