WIND POWER DEMONSTRATION AND SITING PROBLEMS

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I would like to discuss the nature of the work being done at the University of Oklahoma on wind-power generation and on systems associated with the use of nonpolluting energy sources. Our activities are primarily student-oriented programs aimed at specific educational goals. They result from a conviction that wind power represents the most practical way to harness solar energy. The fact that Oklahoma is more than generously endowed with wind is also clearly a factor.

At the same time, we concentrated on the development of a nonpolluting urban car that could use the resulting electrical energy directly. We saw the two programs as being both educational and a contribution to an increasingly critical social problem. We also felt that such programs encourage engineering students to think in terms of social goals, an area which must become increasingly important in engineering education.

In order to insure a general acceptance of alternatives to fossil fuels, research in energy generation and in compatible energy usage must be carried on in parallel. In the long run, there must be alternatives to the "fuel tank" energy economy on which our present transportation systems are based.

Speaking first of the transportation aspect, figure 1 shows the OU Urban Car, a two-seat electric vehicle with an on-board auxiliary generator for extending the range and providing power for heating and cooling. The range of the car is 25 miles on battery power alone and 50 miles with the on-board charger operating. A design goal was to avoid the excessive weight problem which has reduced the performance and efficiency of many electric vehicles. Our test program includes measurements of performance, drag, rolling friction, battery discharge characteristics, and various other technical features. It also includes an operational test program to determine the acceptability of the concept in regular daily use.

The windmill studies have included technical and economic feasibility studies and a hardware program for a small generator that can provide overnight charging for the OU Urban Car. The blades for this mill have a diameter of 12 feet and are coupled through V-belts to a conventional automobile alternator. Under average wind conditions, the mill is capable of completely charging the car batteries in 8 hours.

We have recently embarked on a program of modeling the dynamic response of windmill systems using real wind characteristics and considering variable inertia, aerodynamic characteristics, and energy storage systems. We plan to look both at the short-term response of the system and the long-term energy balance associated with specific demand patterns.

In this connection, OU is fortunate in having the National Severe Storms Laboratory of NOAA located on campus. NSSL has a 44-station recording complex in Oklahoma and Texas, as shown in figure 2 (ref. 1). These stations record wind direction, wind speed, pressure, temperature, and precipitation. The number of stations per unit area is very nearly an order of magnitude greater in the Oklahoma City-Norman area than is currently available in most synoptic data. The purpose, of course, is to provide an accurate portrayal of the surface winds during thunderstorm activities. It is particularly valuable for investigating the siting and performance of wind-power devices.

In addition, NSSL has instrumented the WKY-TV tower to obtain information on the variation of wind characteristics with height. It is located within the area of high-station density for the NSSL surface network. In addition to ground-level measurements, the WKY-TV tower is instrumented at six levels from 146 feet to 1458 feet. Continuous measurements of wind speed, wind direction, and temperature have been recorded since 1966 (ref. 2). The information has been digitized and is available both as annualized velocity and directional distribution and in the form of short-term velocity distributions with intervals of 2 seconds, 10 seconds, and 1 minute. It is these data that serve as one input to our windmill response modeling program.

Since the program is just starting, I believe it is too early to discuss the project in any detail beyond commenting that our goals are to investigate the effect of short-term gusts on the windmill/storage system characteristics and the effect of long-term variations on energy storage requirements with various cut-in speeds and installed capacities.

I would like now to comment briefly on what I see as some of the research needs in the field of wind power.

First of all, I do not believe that we need general concept studies. The concepts exist and, for the most part, the technologies also exist. It seems clear that the development of wind-power systems can be thought of in terms of relatively straightforward engineering programs. The critical element is the willingness of government and industry to make the necessary commitment to policies that will encourage the development and use of wind power. This support need not be expensive, certainly quite inexpensive when compared with AEC funding, for example, and could take the form of development grants and subsidies. Both are consistent with past government efforts to promote the use of emerging technologies. Perhaps even more important, the expression of government interest can have a multiplying effect on independent research carried out by industries and in the universities.

I would like to emphasize particularly the role of practical demonstrations rather than an extensive program of concept and feasibility studies. The subject is old. It has been reviewed and investigated by innumerable competent people over the years and, as Dr. Hutter's presentation showed, the technology itself has reached a high level of development in Germany and in other parts of the world.

As an example of the early recognition of some seemingly-new concepts, I would like to quote J. B. S. Haldane, the eminent British biochemist, writer, and teacher. In 1920, in a small book entitled "Daedalus or Science and the Future," he wrote:

> "Ultimately we shall have to tap these intermittent but inexhaustible sources of power, the wind and sunlight. The problem is simply one of storing their energy in a form as convenient as coal or petrol."

He went on to say that the energy problem would be solved when:

> "...at suitable distances, there will be great power stations, where during windy weather the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen. These gases will be liquified and stored in vats, vacuum jacket reservoirs, probably sunk in the ground."

Note the word "intermittent." For the eventual optimization of windmill/storage systems, we need to know how intermittent and we need to know in some detail. The usual velocity information is obtained at relatively wide intervals of time, which permits a comparative, and therefore rational, basis for siting wind power stations. It does not provide the detailed information needed by the designer to fine-tune the optimization process. The point is that detailed wind information is desirable for the long-term applications of wind power, but its lack need not stand in the way of early demonstration programs.

From the purely technical standpoint, we need better information on the performance of windmills in the vicinity of fixed obstacles and when operating in tandem. We need better methods for modeling boundary layers up to 500 feet in a variety of terrains and with relatively few data-points. We need to develop low-cost blade and tower structures, reliable control systems and efficient storage methods.

Perhaps even more important is the need to consider the matter of social impacts and public acceptance. The appearance of individual mills is important and the siting must be reasonably unobtrusive and based on careful public preparation.

I do not believe the latter point can be overemphasized. Only a few years ago, nuclear power was being hailed as the ultimate source of clean, nonpolluting and inexhaustible energy. Environmental considerations and public objections have essentially halted new construction of nuclear power plants, and the prospects for the immediate future are not bright.

In this connection, a recent study at the University of Texas reviewed the siting problems of a variety of nuclear power plants and compared their public acceptance with the approach taken during their early development. The study found that the successful programs had followed a consistent pattern of full public disclosure, even to the point of announcing where the power plant would be located before completing the plans and buying the land. Although the land costs were higher as a consequence of this policy, the overall costs were considerably less than those associated with strong and well-organized public opposition.

The point to be made here, I believe, is that conventional business wisdom is not necessarily the best guide to decisions that have a strong public impact. In the long run, there would appear to be no substitute for full public disclosure and adequate public discussion prior to a major commitment of funds.

Finally, I would like to address briefly the subject of how development and demonstration of wind power might best be carried out.

I believe that we must avoid the trend toward technological overkill. By this I mean that we should not attempt to do the definitive study in 6 months with 50 people. I recognize that there is often a considerable pressure on funding agencies to come up with early judgments, but if the information is hurried and if the judgments are not mature, it is likely that more harm than good will result.

I make this comment because it seems to me that I have seen a growing tendency on the part of funding agencies to send out RFP's with extremely short response time and high manpower densities. I happen to believe that this is not an efficient way to get at the type of long-term problem which wind power represents. I do not mean that we should neglect certain large or comprehensive studies, but I do believe it is valuable to take advantage of the widespread interest in new power sources by parceling out a relatively large number of small grants. Such grants serve as seed money for other sources of sponsorship and, if issued in the form of student support, for example, have a strong multiplying effect by involving interested faculty members without cost. Furthermore, such programs give the sponsoring agencies a calibration on the interest and competence of the various universities and organizations, which is bound to be helpful when considering commitments to larger or more expensive programs.

It is important to strike a reasonable balance between research, system studies, and demonstration projects.

Aside from the technical programs, we should place a strong emphasis on public policy issues, the effect of the technology on society, and the interaction of State and Federal regulatory actions.

REFERENCES

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2. Crawford, K. C. and Hudson, H. R. Behavior of Winds in the Lowest 1500 Feet in Central Oklahoma: June 1966 - May 1967, ESSA Technical Memorandum ERLTM-NSSL 48.

Figure 1

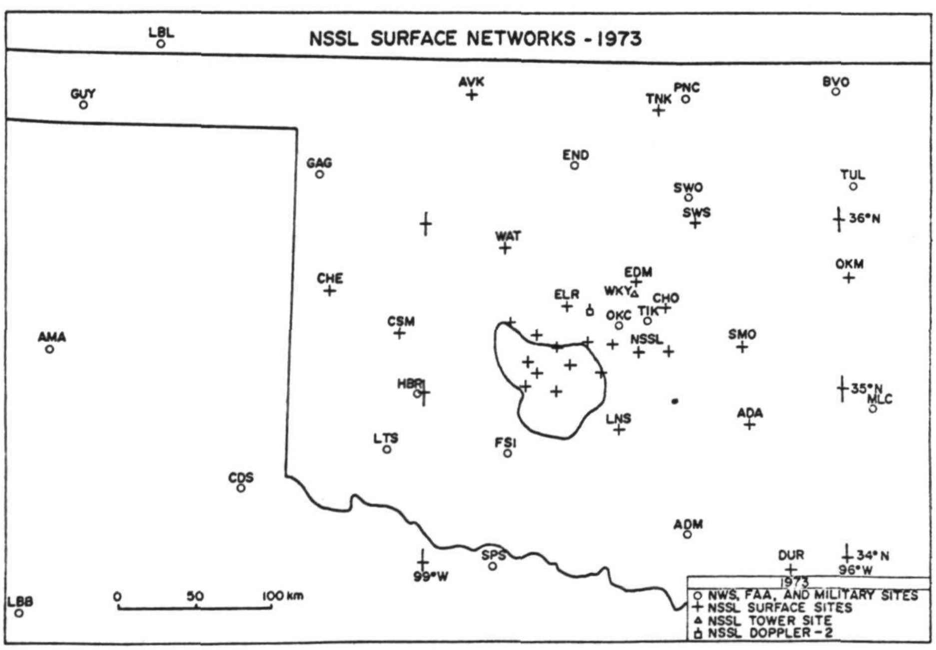

Figure 2