WIND POWER SYSTEMS FOR INDIVIDUAL APPLICATIONS

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Mr. Chairman, ladies and gentlemen, I suppose the reason I am here this morning is to tell you something of my experience in the last year or so with a modern small wind electric generating system.

Specifically, I have lived for the past year (with my wife and two children) in a house which is completely electrified by wind power. We get all of our power for lights, household appliances, shop tools, etcetera -- even a television set -- from wind power. Our wind power system, which is completely self-contained, consists of a two-kilowatt wind driven generator, a set of 19 storage batteries (giving us enough reserve power for 4 days without wind), a small dc to ac inverter, and a gasoline generator which we use as an emergency backup system in case of prolonged calm periods.

Now we installed this system ourselves, but we did not design it or build it. The entire system is based on commercially available production components which, in fact, can be obtained right now by anyone here. And, I guess my basic message to you today is that there <u>is</u> equipment in production right now which has been tested and proven and which can be put to immediate use in many small-scale applications. And further, and this may come as a surprise, there are many applications where wind-generated power is actually cheaper than conventional generating systems.

Let me start by giving you a little background on our installation to illustrate this point. When we moved to Maine two years ago and started building our house back in the woods (we're actually located 5 miles from the nearest paved road), we were faced with the problem of supplying electricity to our home in the wilds of Maine. The local power company looked at our situation and came up with a quote of 3000 dollars to bring us in a line. And they wanted a minimum of fifteen dollars per month for the next 5 years regardless of how much power we used.

Well, this was enough to make us stop and think a bit. But what really are the alternatives in a situation like this? The only alternative usually considered, if power lines are not available, is a small diesel or gasoline generating set, but the economy of such a system is very poor (not to mention the noise and pollution problems). A rough estimate of the cost of power generated by such a domestic generating set, diesel or gasoline, taking into account capital costs, fuel, and maintenance expenses, is 30 cents per kilowatt-hour or about 10 times the power company rate!

Now, here is where the wind-generated power comes in. Wind generated power may not compete at present with mass-produced power from the power company, but it does compete very favorably with any other type of individual power plant. Our complete installation, which I will describe in a minute, cost us $2800. There is, of course, no fuel expense, and the only maintenance associated with this system consists of changing the oil in the gearbox (1 quart) once every 5 years. Assuming, conservatively, a 10-year life for the batteries and a 20-year life for the other components and adding in maintenance and interest costs on the investment, the total costs to us of the electricity generated by our windmill comes out to about 15 cents per kilowatt-hour - or about one half the cost of the gasoline or diesel plant. This is based on an average power output of 1500 kilowatt-hours per year (120kW-hr per month) in a location with 8 to 10 mph average winds.

So, you see, in our case (and in similar cases throughout the country where power lines are not easily available), wind generated power can actually represent the cheapest available means of generating power. It is for this reason that I predict we will witness the reappearance of modern wind-electric power systems, at least on a small scale, in the coming years.

Now for a brief description of our set up in Maine. I won't go into too much detail because the whole system is described quite completely in a small booklet which we have printed recently entitled "Electric Power from the Wind." This publication, which we offer through the Solar Wind Company for one dollar postpaid, describes the operation of modern small self-contained wind electric power systems and has several tables and diagrams which allow you to calculate the power output of various size systems under various wind-speed conditions.

Our basic system consists of a 2-kilowatt Quirk's wind generator manufactured in Australia. This "windplant" as they call it, uses a 12-foot diameter propeller with a full-feathering hub controlled by centrifugal weights. The generator is a 2000-watt, three-phase, 115 volt dc, which we feed through the voltage regulator panel (included with the Quirks unit) to the batteries. This panel contains large ampere and volt meters as well as a transisterized voltage control which works by lowering the voltage to the alternator-field (thus reducing the charge rate) when the output voltage exceeds a certain value -- which you can set to correspond to the voltage of the batteries in their fully charge state. Above the panel you will see the anemometer readout, which reads the windspeed in mph at the windmill site. For storage during calm periods we use 19 lead-acid storage batteries, rated at 130 ampere-hours and 6 volts each. These give us a total of 15 kilowatt-hours of storage at 115 volts. These batteries are especially built for this type of application; they have built-in charge indicators in each cell. These batteries come from Australia and seem to be cheaper than American batteries of the same capacity. We sell a 19-battery set of these in New England for $695 or about $35 apiece.

In our installation we use much of our power directly at 115 volt dc. All our lights, many appliances including the vacuum cleaner, electric

drill, skill saw, sewing machine, etc. will run well on dc. Our water pump also has been converted to run on dc. The only appliances which require ac are the television and the stereo and for these we use a small surplus rotary inverter which we purchased for under $100. Of course, for larger loads, there are several types of electronic solid-state inverters available and we are now selling units up to 8000 watts. As an example of costs on these, a 2000-watt unit sells for about $1600.

And now let me move on to some more recent developments. In addition to our arrangement with the Australian company, the Solar Wind Company has recently contracted for an agency in the U.S. for the wind driven generating equipment manufactured by Elektro G.m.b.H of Winterthur, Switzerland. It is our feeling that at present this company manufactures one of the best units available for the price anywhere in the world. (The Aerowatt unit made in France may be superior in certain respects, but they are more expensive than comparable Elektro models.)

Elektro makes several different size units. They make two small vertical axis mills rated at 50 and 250 watts in wind speeds of 40 mph. Then they make conventional units in sizes from 750 to 6000 watts output. The 6-kilowatt model delivers its full output at a wind speed of 25 mph. Typical monthly outputs from this 6-kilowatt generator are: 350 kilowatt-hours in a 10 mph average wind, 470 kilowatt-hours in a 12 mph wind, and perhaps 600 kilowatt-hours in an area where the average wind speed is 14 mph.

We have recently installed one of these large Elektro units beside our Quirks unit for testing and evaluation. So far it has performed very well, and preliminary tests show that it will produce about three times the monthly average output of the 2-kilowatt Quirks unit. The output of the Elektro unit is controlled by a servomotor at the base of the tower which operates by tensioning cable running up the center of the tower, and thus regulating generator output by rotating the tail and causing the unit to turn out of the wind. The windmill can thus be operated at any power setting from 100 to 0 percent by this control. The control can be actuated manually and remotely by push buttons or automatically by various factors. These include over-voltaging of the batteries, too high current in the generator, and excessive wind speed. A small wind paddle attached to the tower closes a contact in winds over 60 mph putting the windmill out of operation for a period of 12 hours, after which it will again start up automatically if the winds have abated. With the automatic control all the Elektro units are capable of completely automatic and unattended operation in winds as high as 150 mph.

The Elektro Model WVG-5, 6-kilowatt windplant is the largest unit currently in production. It has a three-bladed propeller of 16½ foot diameter and, like the Quirks unit, uses a centrifugally operated feathering system to limit propeller and generator rpm to safe maximum levels. The price of this unit, delivered on the East Coast with automatic controls, is about $3000.

Now I'd like to make a few comments about what I see to be the

immediate future of small scale wind-driven power systems. Besides the sort of direct residential electrical power systems which I have just described, I think the most promising area for small wind generators may well be in the area of domestic heating. Some preliminary figures show that wind-driven generators in the 15- to 25-kilowatt output range, coupled to a direct heat storage system using heated water (no batteries) would very adequately heat a typical six or eight room New England home. The cost of this system might easily be made competitive with present oil or electric heating systems. Right now such a system could be set up using existing production components for about $7500 total capital cost with virtually no expenses thereafter for maintenance or fuel for a period of at least 20 years. And there is no doubt that the price will come down if any quantity of such installations is contemplated.

This brings me to my final point here today. I think if we are to get on with the job of developing satisfactory alternatives to our present fuels, we will have to approach the problem on many levels. Obviously, one wind powered home in Maine has little significance on the national energy crisis. But I feel that one operating wind power system, small though it may be, can demonstrate to many people that the wind is a viable and even practical source of energy for the future. For many people this is a more convincing demonstration than some of the ambitious proposals and schemes which seem destined to remain in the conceptual stages for years to come.

If we want to foster the idea of wind power as a viable alternative to present methods, we must support efforts to harness the wind at all levels. As I see it, the small and modest projects that we are involved in right now could be vitally important to the future acceptance of wind power on a larger scale, and so it is perhaps in this way that our work is significant on a national level.

DISCUSSION

Q: You said "we." Who does "we" refer to?
A: Well, at the moment the Solar Wind Company consists of myself, my wife, and secretary. We have another fellow joining up this summer who will be working with us, and my brother also collaborates. He is an architect. It is a very small company, we have only been in existence about 4 months. Our main work is to import these Australian and Swiss units.

Q: How much would the cost be affected by a loss of skilled manpower to erect and maintain these units?
A: My wife and I installed both of these units with the help of a pickup truck, guy wires, and a jin pole, and so on. So they can be put up in the field with very little skilled labor. They come with a set of directions and are really not hard to install at all.

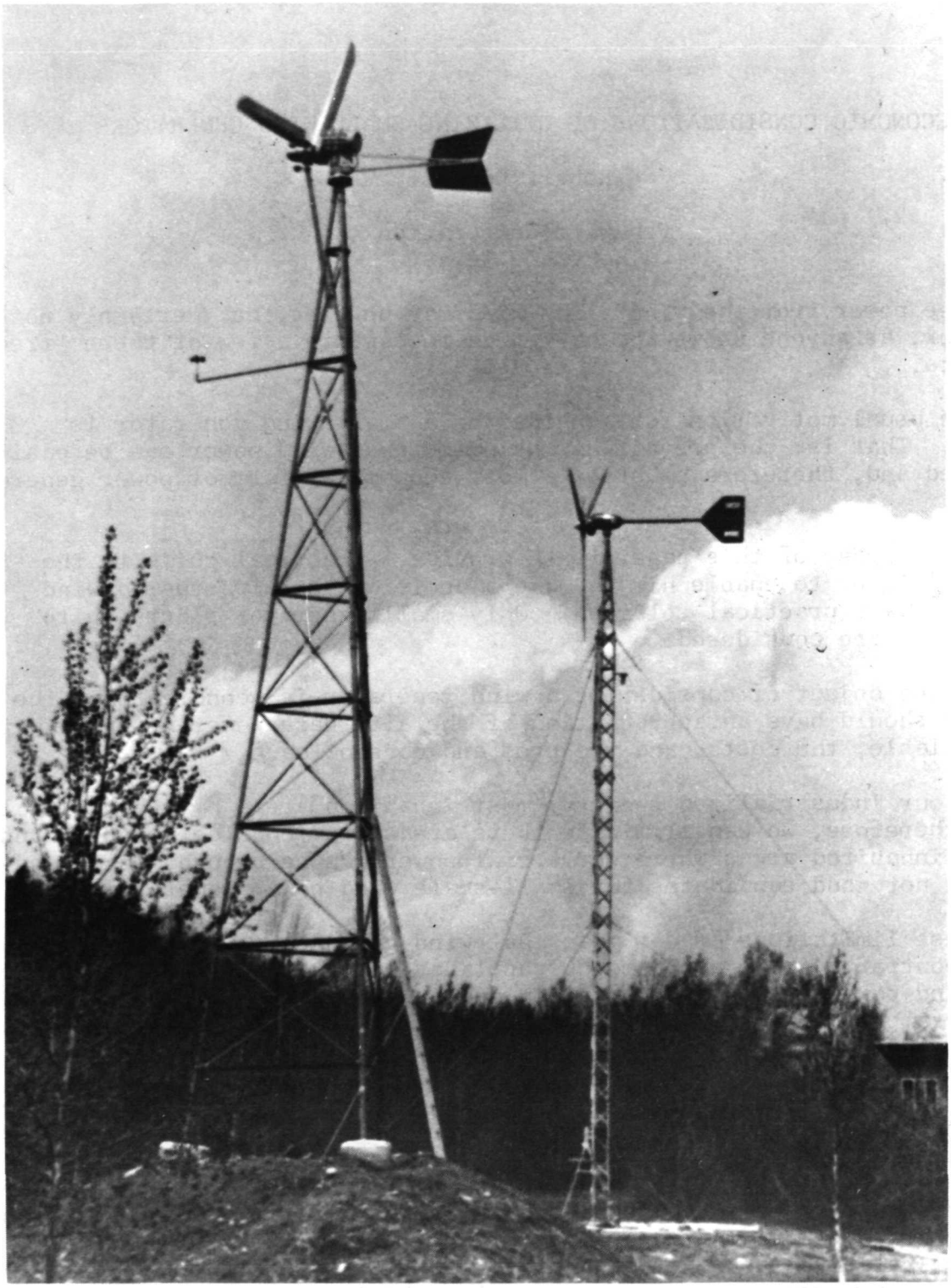

Figure 1. - Foreground: 2 kW Quirk wind generator
Background: 6 kW Elektro wind generator