INTRODUCTION TO VOIGT'S WIND POWER PLANT

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The late Hellmut R. Voigt's manuscript entitled "Von der Windmuhle zum Winderaftwerk" -- ("The Design and Operation of Wind Power Plants") comprises 230 pages and 270 illustrations. One of the leading authorities that certified the document was Professor Flugel, Hannover, Germany. This investigation has been examined by experts of leading universities (found in the bibliography of the text) who all testified to the correctness of the author's findings of his own wind power plants. Other engineering authorities who personally certified Hellmut's document were Professors Pantell, Witte, and Schleichert.

The Cyclone D-30 is a high-speed three bladed wind turbine (diameter, 30 m) that operates at a height of 50 meters. The blades are rigidly connected to the hub and the revolutions of the turbine change linearly with the wind velocity, maintaining a constant speed ratio of u (blade tip velocity) to v (wind velocity). This "ideal" wind turbine holds its high efficiency over the full predetermined range of wind velocities. The three generators installed in the gondola generate either dc or ac current. In case of dc installation, the turbine turns by means of a transmission, a set of dynamos. In case of ac installation, the turbine turns by means of an infinitely variable speed drive (patented), a set of synchronous three-phase generators. The generator-gondola with its streamlined shaft can turn around the tapered mast top by means of a journal bearing and a king pin. This motion is controlled automatically by two wind rosettes in such a way that the wind turbine always opposes the wind direction. The mast, a truss and shell construction, pivots about a central foundation and is held in position by steel cables. The wind turbine is equipped with an aerodynamic brake system, and the blades are equipped with an anti-icing system. The low-speed control wind turbine (3-m diameter) located at the tip of the gondola, controls load and speed of the wind turbine by means of a differential regulator driven by both the main and the control wind turbine (patented). The total efficiency of the wind power plant is 66 percent.

Based on the wind conditions at Cuxhaven, Germany, the maximum output is 720 kilowatts at a wind velocity of 16 meters per second. The total installed electrical capacity is 750 kilowatts, and the power output pear year is 2,125,000 kilowatt-hours.

The turn-key installation cost of a wind power plant is not a function of its installed electrical capacity as in steam or diesel power plants. The cost is determined by its towering structure, which has to

withstand maximum wind gusts of 50 meters per second (115 mph). The installation cost of a wind power plant should be plotted versus the wind turbine diameter. Such a curve leads to the conclusion that a plant with a 30-meter wind turbine diameter represents the optimum in costs. The price per output rises quite rapidly for smaller wind turbine diameters, as well as for larger ones. In 1951, the turn-key installation cost of a wind power plant Cyclone D-30 was about $244,000.

The operating cost of a wind power plant is not a function of the installed capacity but instead depends on the number of wind power plants operated in a certain area. The more plants that are interconnected to form a wind power central, the lower the operating cost. For instance, in my feasibility study at Cascade Locks, Oregon (Bonneville Dam sector) one unit produced over 14,000,000 kilowatt hours per year for approximately 68.3 percent of the time per year at about 4.3 mills per kilowatt-hour. If 20 units were located, the cost is reduced to approximately 0.8 mill per kilowatt-hour.

The cost savings of a nonweather vaning aggregate over a weather vaning aggregate amounts to $25,000, or about 10 percent of the total installation costs. The difference in operating costs is almost negligible.

Mechanical coupling of wind turbine and water pump is prohibitive, due to the tremendous torques developed by a wind turbine of considerable size.

We have included the production of hydrogen from the electrolysis of water for producing electricity by the hydrogen fuel cell. The installation of this system would supply the needed electricity during peak load demands or augment power during the year, if wind velocity is below the prescribed velocity (8 mph).

Some technical data of the TORNADO wind power plant DIOO are as follows:

Diameter of wind turbine, ft	100
Operating height of wind turbine, ft	150
Total height of wind power plant, ft	200
Diameter of generator gondola, ft	10
Diameter of supporting tubular tower, ft	7.5
Height of observation platform, ft	90
Diameter of air rosettes, ft	12
Speed range of wind turbine, rpm	15 to 60
Utilized wind velocity range, mph	9 to 36
Average annual power output:	
kW	250
HP	340
Maximum power output:	
kW	700
HP	950

Annual net current output, kWH	2,125,000
Normal voltages:	
dc	440
ac	525
Total efficiency of wind power plant, percent	66

DISCUSSION

Q: What year were those dollars?
A: 1951 dollars.

Q: I didn't quite understand the meaning of the 66 percent efficiency.
A: This is the total overall efficiency, including mechanical.

Q: From the total energy?
A: Yes.

Q: Assuming an ideal windmill is 100 percent?
A: Yes.

Q: Which is an efficiency of about 60 or 70 percent ideally?
A: The ideal is 59.3.

Q: 59.3 times about 60 then.
A: Yes, so it takes it down to about 40.

Q: About 40?
A: The overall power coefficient.

Q: Let's go through that just once more to make sure everybody agrees. If you have a hundred energy units in the wind, an ideal windmill will give 59.3 percent. Now you are saying you can expect 66 percent of that 59?
A: True.

Q: Since Dr. Tomkins didn't have any slides, I'm not sure whether he built one of these or what.
A: No, this was design based on a small unit. This was simply the design. The two units were built for the 50-foot units, not the 100.

Q: I would like to hear some comments on the availability of some of the older windmills. For instance, if somebody wants a 50-kilowatt unit, are any of these available to be rehabilitated? Where can you buy a 50-kilowatt unit - who deals with used windmills?
A: The unit just discussed was not an actual unit but a prototype. However, the data that have been compiled were on actual units (12½ feet, 25 feet, and 50 feet). Mr. Voight didn't live to realize a 100 foot unit.

Q: Is it being built now?
A: No. There seems to be a lack of interest as far as funding is concerned.

Q: Are there windmill units that are available as a production kind of unit or as a used unit?

A-1: The machine just shown in the film (the 100-kW Hutter-Allgaier machine) can be produced, but it would be much more expensive than under the conditions we were working on then. We built about 1800 plants of 10-meter plants (10 kW). There is a fine market, like used cars, for these plants. If anybody has a plant to sell, there are five buyers. There is a market. Plants of the size I have shown are available. It's a question of delivery and price.

A-2: I have been doing some research to find out if there are any in production. Those I found are small-scale units up to about 5 kilowatts. There is a company in Switzerland building a 5-kilowatt unit with a 5-meter diameter blade, and they are in regular production. You can order one and get it in 6 weeks. As far as I know, this 5-kilowatt unit is the largest unit presently in production in any quantity.

Q: Do you know the cost?

A: The unit itself, the wind plant, and the control system cost about $1,900. Freight to this country is not a large factor - about $200.

Q: Now we are selling a minimum power. They need 14 knots of wind, have a diameter of 9.2 meters, and they deliver ac current. They can be used to either charge batteries or produce wattage. We can accept orders for 4.21 machines.

Q: This machine is in production, 4.1 kilowatts, and 9 meters in diameter?

A: Yes. In 2 weeks I'll have photographs of this machine. Last month we tested 4.6-kilowatt machines.

A: There is a machine made in Germany which will generate a maximum of 400 watts ac, rectified dc for charging batteries. It is very useful for household purposes. There is another one in Italy which will generate 1000 watts, very much the same thing, but it's dc. There is also a machine in production which can generate about 40 horsepower dc in a 30-mile-an-hour wind.