Evaluation of Five Wind-Powered Electrical Systems

Wind-powered electrical systems played an important role in the electrification of many rural homesteads thirty or forty years ago. During the energy crisis of the 1970s, wind systems regained popularity, and new companies specializing in wind systems began trying to develop more powerful and efficient products. In one example is the Smith Putnam Company which built a huge wind system with a propeller diameter of 175 ft and a maximum power output of 1.25 million watts, but it only lasted two years because one of its twin blades snapped at the base. Another company, Dyna Technology, designed a wind system with a maximum power output of 200 watts to power radio stations in remote areas. The following discussion will focus instead on wind systems that can produce 2000 watts of power which is sufficient for one household.

Figure 1. The North Wind Eagle Generator

Points of Comparison The ideal wind system produces sufficient power in slow wind speeds, lasts for a lifetime, and cost relatively little. Because wind systems come in many different models, this report is limited to five designs, shown in Figure 1, with each design from a different company. The Eagle, the Kedco (Model 1600), and the Dunlite wind systems are a few of the more common wind systems on the market. The Darrieus wind system uses a vertical axis rotor and is not very popular because it does not follow the conventional design of most wind systems. The Zephyr system is one of the newest wind systems and is not yet available on the market except for research purposes.

Although there is quite a variety of designs, three of the primary considerations in selecting a wind system are (a) power output, (b) durability, and (c) cost. Power Output. The ideal wind system should charge the storage batteries faster than the electricity is consumed. Since a low-power wind system eventually charges the batteries, the rotor should have a low cut-in speed to take advantage of slow winds. To charge the batteries quickly, the generator should produce at least 2000 watts in a moderate wind speed.

The Eagle reaches a maximum of 2000 watts in winds of 20 mph. It accomplishes this output by using a special slow-speed generator and a rotor with a 14 ft diameter. The generator starts producing power in winds of 8 to 10 mph. The Keco produces 1200 watts in 17 mph winds using a 16 ft rotor. The Dunlite has a rotor diameter of 13 ft and a cut-in speed of 10 mph. In 25 mph winds, the Dunlite attains its maximum power of 2000 watts. The vertical-axis Darrieus requires a motor to start the rotor, but it can produce 4000 watts in a 23 mph wind. The vertical-axis twin-bladed rotor stands 15 ft high allowing it to absorb more wind energy. The Zephyr, still being tested, can produce 15,000 watts in a 30 mph wind. At cut-in speed it delivers 500 watts of power, an output that is accomplished by using a special low-speed, direct-driven (gearless) rotor with lightweight blades approximately 14 ft in diameter.

Durability. Obviously, a wind system that lasts a long time can pay for itself in savings from electric bills. Many wind generators have short lifespans because the blades break as a result of the vibrations from high wind speeds. This problem can be solved with some type of governor or braking device to slow the rotor down in high winds. Brush wear is another problem that cuts the lifetime of a wind system, but this problem is easily corrected by using the long-lasting brushes designed by Jacobs Wind Electric Plants.

The Eagle has proven itself to last about 20 years. The rotor uses a flyball governor to turn the blades and to vary the pitch of the wind. The brushes have also been designed for long life. Since the Eagle's generator is directly turned by the rotor, no gears are needed and the system lasts longer. The Kedco uses aluminum blades that feather (or bend) in high winds. It also uses uses an automatic vibration sensor that shuts off the generator in turbulent winds. The Dunlite has been on the market for 30 years and has proven itself to be reliable. The variable pitch blades are made of galvanized steel and are designed to withstand winds up to 80 mph. The Dunlite generator is designed without any brushes which gives the system longer life. The Zephyr system uses glide-out spoilers on the blades to protect against overspeed. Because it is still in the testing phase, the lifetime is unknown at this time. The vertical-axis Darrieus system is designed to withstand gusts of 130 mph. The vibration is kept at a minimum because the system's center of gravity is along the rotor shaft.

Cost. The Eagle system sells for $3500. This price does not include the tower, inverter, or the storage batteries. The total cost is approximately $4700, but the Eagle is maintenance-free for about 15 to 20 years. The Kedco 1600 sells for $2895. This price does not include the tower and other accessories so the total cost is around $4000. The Dunlite system costs $2000 in Australia where it is manufactured. Adding the costs of delivery and accessories raises the total cost to about $4500. The Zephyr costs $12,000 including the tower and control panel. Should tests and time prove the design to be a good one, public confidence may increase as will production, and thus the price should decrease. For the time, however, the vertical-axis Darrieus, costing $8000 complete with tower and electrical control gear, is the reasonable choice.

Conclusions For people who are considering an investment in a wind system, cost is probably the most important factor because these people are already trying to trim their electric bills and save money. The real savings begin when the wind system has paid for itself in electric bill savings. If a household averages a monthly electric bill of $120 and purchases a $4700 Eagle, then the real savings will begin in about three and a half years after the date of the purchase. The cost-efficiency of a wind system can be calculated by dividing the cost of the system by its lifetime.

From the preceding comparison of power, durability, and cost, the following conclusions can be stated:

- The most powerful system is the Zephyr followed by the Darrieus.
- The Dunlite has the longest lifetime followed by the Eagle. The Darrieus can withstand the strongest wind.
- The system with the best cost-efficiency is the Dunlite at $150 per year. If the Eagle reduced its price by $1700, it would equal the Dunlite in cost-efficiency.

Table 1 shows a factual summary of these comparisons. Notice that maximum power and cut-in speed is used to evaluate a wind system's power performance.

Table 1. Factual Summary of Wind Systems

Wind machine	Max. Power/ wind speed	Cut-in wind speed	Cost in dollars	Lifespan in years
Eagle	2000/20 mph	8-10	$4700	20
Kedco	1200/17 mph	----	2895	--
Dunlite	2000/25 mph	10	4500	30
Darrieus	4000/23 mph	motor start	8000	--
Zephyr	15000/30 mph	10	12000	--