CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)

Jonathan J. Crowther

Project Number

J0105

Project Title

Out of Thin Air: Harnessing Wind Energy with an Efficient Blade Design

Abstract

Objectives/Goals

The purpose of my project was to test different blade designs in order to find the most efficient design. I wanted to learn if blade shape, size, angle, and number influence a turbine#s efficiency. My hypothesis is that if three long and narrow blades are used on a wind turbine, resembling current commercial designs, then more energy will be produced.

Methods/Materials

I made a testing apparatus from a piece of plywood, PVC pipe and fittings, a household fan, and assorted hardware. I bought a small hub and generator off the Internet. Blades were made from light card stock, small dowels, tape, and cyanoacrylate glue. I used a kit with small gears and shafts in it to make a small gearbox to multiply the rotating speed of the generator by 7-fold. I tested for the design that could do the most work, measured as maximum sustained milliamps output under load, an indicator of highest torque. I also tested aerodynamic performance, measured as maximum sustained no-load voltage, an indicator of the fastest spin rate and therefore the lowest aerodynamic drag. I made and tested a total of eight blade designs (all but one using a horizontal-shaft design). Each design was tested using different blade angles and number of blades, in order to find the combinations that made the most power, in milliamps, indicating, as well as the highest Voltage, indicating the fastest rotation.

Results

My hypothesis was proven wrong. The miniaturized commercial design using long, narrow blades was a total failure in my testing system. The best blade design had large surface area, and three blades were optimal for a balance of aerodynamic performance and torque production.

Conclusions/Discussion

I have learned that, at least for small turbines, the larger the surface area of the blade, the more power made. Also, it looks like three blades work best, because they can catch enough wind without creating too much drag. Further, shifting more of the surface area away from the hub creates more torque when the total surface area and swept area are held constant. The best blade angle depends on the design, but should be between 30° and 45°. Finally, I think that my experiment shows that more useful data can be acquired by including an apparatus that stresses the system, such as my stepped-up gearbox.

Summary Statement

My project is a search for a small scale blade design, number of blades, and blade angle that extracts the most energy from wind and coverts it into usable torque.

Help Received

My Dad helped me obtain materials, provided guidance throughout the project, taught me to use the tools needed. He performed step he considered dangerous, like drilling through steel with a 2mm bit in a hand drill. He turned the fan on/off, discussed my observations with me and took pictures.