Wind Harvest Company Prototype - Windstar 480-4

Concord, CA | Installed 1984

Wind Harvest Company's Windstar 480-4 took the previous iteration, the Windstar 256 model, beefed it up, and increased its size by adding a third module and increased blade length from 8 to 10 feet and thus rotor height from 16 to 30 ft. This model also featured a newly designed drive train/generator/control system and brake.

Model 480-4 Specifications	
Rotor Height (m)	9.1
Rotor Diameter (m)	4.9
Swept Area (m^2)	44.6
Number of modules	3
Number of blades per module	4
Number of stators	5
Turbine Spacing	3 rotor diameters
Solidity	33%

The main features of this model were as follows:

- Two sets of gear belts, one for each generator
- Two generators, one at 25kW at a rotor speed of 80 rpm and the other at about 7kW with a rotor speed of 60 rpm. Three-phase, 460 v induction type.
- Solid-state controller, which turned the generator on and off via motor contractors. Designed by Ben Parks.

Lessons Learned

There were many problems with this model, especially with the rotor.

- Blade construction was not good.
- Oil canning was severe.
- Braking was marginal.
- The belts slipped on the 25kW generator even though they were gear belts.
- The controller had problems.
- Frame needed strengthening.
- Blade support rods were used instead of cables, and they fatigued due to bending, and cables had to be used.

2nd iteration

After discovering all the issues surrounding this turbine, the team decided to test efficient fiberglass (but expensive) blades to discover what high-end efficiency could be achieved with the Windstar. The fiberglass blades were in a NACA 0018 airfoil shape with a 16-inch cord and 10 feet in length. The improved turbine featured the fiberglass blades, an efficient generator, V-belt, and solid shaft sections for each module.

This fiberglass-bladed turbine measured shaft torque and RPM and generator electrical power output. The goal was to construct a shaft power coefficient-blade tip speed ratio curve and compare it to data from other types of designs. Ben Parks designed and set up the measuring system where one of the first commercially available laptop computers collected the data.

The goal of the improved turbine was a 25% improvement. The 480-4 achieved that and more as the calibrated load cells indicated the Windstar's efficiency exceeded the Betz limit (theoretical maximum aerodynamic to mechanical efficiency).

Although the model 480-4 achieved excellent performance results, the team had to go back to the drawing board to improve frame stability and identify efficient yet inexpensive blades.