

10 kW (13 m/s) 5 m Diameter Carbon Fibre Wind Turbine Blades

Abstract

A 10 kW wind turbine blade set has been built for use with the 10 kW, 15 phase Axial flux pancake generator. When attached to the turbine it is estimated to produce approx 4-5 kW of electrical power at 50% efficiency with 8-10 kW of mechanical power driving the generator. The total cost of the turbine blades was AU\$405 and the blades were constructed with typical home-workshop tools.

Keywords: Wind power, Wind turbine blade construction, 10 kW wind turbine, Carbon fibre wind turbine blades

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1. Constructing the interior of the wind turbine blades

Figure 1. Steel blade core

The airfoil shapes were printed using a computer. The printouts were glued on 1 mm steel sheet and cut out.



Figure 2. Skeleton airfoil blade one

The steel airfoil cut-outs were welded on steel tube, with the angle set using a protractor against a plumb line.



Figure 3. Skeleton airfoil blade two



Figure 4. Skeleton filled with polyurethane foam

The skeleton was filled with expanding polyurethane foam (1kg Suprasec 5005, 1kg Daltolac GP33) and sanded into shape.



Figure 5. Polyurethane foam blade after sanding

2. Constructing the exterior of the wind turbine blades



Figure 6. Blade after being covered in chop strand matt fibreglass

The blade was coated in a layer of vinyl ester resin and once the resin had cured, 220 g chop strand matt fibre glass was used to fibreglass the blades. Several layers were used with sanding to ensure a smooth finish.



Figure 7. Blade after being covered in bi-axial glass cloth fibreglass

400g bi-axial glass cloth was wrapped around the blade and fibre glassed in place. It was lightly sanded before applying another layer of chop strand matt.



Figure 8. Blade after being covered in uni-directional carbon fibre

Chop strand matt was sanded into shape before applying the final layer of 197g uni-directional carbon fibre. The carbon fibre is lightly sanded to form a smooth flat blade.



Figure 9. Blade after sanding the carbon fibre



Figure 10. Completed 5 m wind turbine blades

3. Calculated output of the wind turbine system

Output of system at maximum generator output (generator efficiency of 50%)

TSR = 9
 Blade Efficiency = 0.4
 Mechanical Power = 10,525.7 Watts
 Rotational Speed = 446.9 RPM
 Rotational Torque = 224.91 N.m

Running at a TSR of 9, the generator should output 2 kW of electrical power, requiring 4 kW mechanical power

A TSR of 12.5 is a better match to the generator

TSR = 12.5
 Blade Efficiency = 0.3
 Mechanical Power = 7894.3 Watts
 Rotational Speed = 620.7 RPM
 Rotational Torque = 121.45 N.m

Running at a TSR of 12.5 the generator should output 4 kW electrical power, requiring 8 kW mechanical power

4. Total cost of the wind turbine blades

System cost (AUD)

Steel \$25
 Polyurethane \$40
 Matt, cloth, resin and initiator (MEKP) \$220
 Carbon fibre (*increased strength, not essential*) \$120

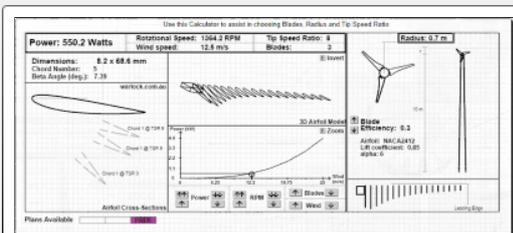
Total cost \$405

Equipment used

Arc welder
 Grinder
 Drill
 Wood saw
 Sand paper
 Fibreglass rollers
 Paint brushes

Conclusion

At a total cost of \$1,278 including the generator, a wind turbine capable of producing 4-5kW electrical power makes a very cheap alternative for power production especially in remote areas.



Design custom blades for your generator and calculate power output at each wind speed.

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