



Vertical Axis Wind Turbines



Goals

- ✓ Assemble a vertical-axis wind turbine
- ✓ Modify it to change its efficiency
- ✓ Make calculations based on data



Background

Wind turbines are quickly becoming a major source of electricity in countries around the world looking to decrease their dependence on harmful fossil fuels. In consistently windy areas, they can provide cheap, clean power nearly constantly. You've probably seen wind farms made up of the tall, three-bladed turbines that spin along a horizontal axis. But there's an entirely different type of wind turbine that spins on a vertical axis.

Vertical-axis wind turbines (VAWTs) have a number of advantages over their horizontal-axis cousins. They can use wind from any direction and so don't need to be turned to face the wind. They are typically much smaller than horizontal turbines and so are much more practical for smaller communities or personal use, while also posing less of a danger to birds and taking up far less space.

VAWTs are separated into two types, named after the engineers who designed them: Sigurd Johannes Savonius and Georges Jean Marie Darrieus. A Darrieus turbine has vertical blades that spin around a center pole by using lift like the wings of an airplane. The slender profile of the blades often makes these turbines resemble egg beaters (see Figure 1).

Savonius turbines, in contrast, are built to use the drag force to power their blades. Instead of being shaped like an airplane wing to allow wind to flow over them, their blades are curved like scoops to catch the wind. Like a series of sails, these blades are pushed by the wind and spin the turbine.



Fig. 1: A Darrieus VAWT

During this activity, we will use a VAWT to generate electricity. We will experiment with different blade configurations to try and maximize the power produced by our wind turbine.



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Procedure

1. Your Savonius VAWT has different slots so that you can assemble your wind turbine with two, three, or four blades. Which configuration do you think will be most effective at producing an electric current?
2. Look at the base for the turbine. It has two coils of wire inside it. Why do you think the coils of wire are necessary?
3. The stator is the part of the turbine that doesn't move. It's the thin rod that fits in the small hole in between the coils of wire. Why does your turbine require a part that remains stationary?
4. Once your stator is in place, you can begin constructing your rotor. First you'll have to decide how many blades you want. You can tell where the blades should go by following the color-coded markings on the top and bottom plates of the rotor.
5. You can tell the top blade plate from the bottom because the bottom of the rotor has four magnets attached to it. Why are magnets necessary?
6. Insert the aluminum rotor pole into the hole in the middle of the bottom blade plate. What purpose does the rotor pole serve?
7. Attach the desired number of blades to the appropriate color-coded slots on the bottom of the rotor.
8. Fit the top blade plate onto the blades and rotor pole, again lining up the appropriate color-coded slots with the turbine blades.
9. Use the blade plate lock to secure the top of the blade plate.
10. Lower the assembled rotor onto the stator on the base.
11. Attach the LEDs to the base using the red and black wires. Why do you think we need two wires?
12. Turn on the fan and observe what happens. Record your observations below.



Observations



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Experimentation

1. Try changing the number of blades in your turbine. Does anything change about how the turbine rotates or the amount of electric current supplied to the LEDs? Record your observations below:

Number of Blades:	Observations:
2	
3	

4	
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2. Move your fan farther away from your turbine. What's the farthest distance it can be before your LEDs no longer light up? Record your observations below:

Number of Blades:	Distance (cm)	Observations:
2		
3		
4		

What arrangement worked at the farthest distance?



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Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, [click here](#).

1. Move the fan closer to the turbine and record the current in Amps and highest voltage in Volts produced while the turbine is powering the LEDs. Record your answers below:

Current: _____ A

Voltage: _____ V

2. Voltage is equal to the current in amps multiplied by the resistance in ohms ($V = IR$), so according to your data what is the resistance of the LEDs in ohms?

Resistance: _____ Ω

3. Try to maximize the output of the current and voltage by changing the number of blades. Record your results below:

Number of Blades:	Current (A):	Voltage (V):
2		
3		
4		

4. Power is current times voltage ($P = IV$). Calculate the maximum power in watts of your turbine and compare it to the reading you get on the Energy Monitor. What might account for any differences you notice?



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Analysis

1. Make a scientific claim about what you observed while running your wind turbine.
2. What evidence do you have to back up your scientific claim?
3. What reasoning did you use to support your claim?
4. Design an experiment that would determine the best shape for the wind turbine's blades. Explain the steps of your experiment below:

