How to Build a Wind Turbine for Your Science Fair (or fun)

Background Information

Wind turbines are classified into two types depending on its axis of rotation. The turbines that have a horizontal axis of rotation are called Horizontal Axis Wind Turbines (HAWT). Here the axis of rotation is parallel to the ground. In a Vertical Axis Wind Turbine (VAWT), the rotor rotates against a vertical rotor shaft. Depending on the type of rotor blades, VAWT is further classified into Darrieus model, Giromill, Helical Blade VAWT, Cyclo-turbine and Savonius. Darrieus and Savonius are the two basic models. Other models are modifications of Darrieus model.

One main difference of Darrieus and Savonius models is that the former uses the lift force for its function and the working principle is similar to a HAWT which also uses the lift force to generate power. The Savonius model makes use of the drag force and this makes its rotation very slow. It will have two blades. One side of the blade will catch the wind more than the other and this rotates the rotor. Because of this, a Savonius turbine cannot rotate faster than the wind. Since it is slow-rotating its efficiency is very low and is used for low power functions like operating pumps etc. this cannot be used in areas with slower wind speed.

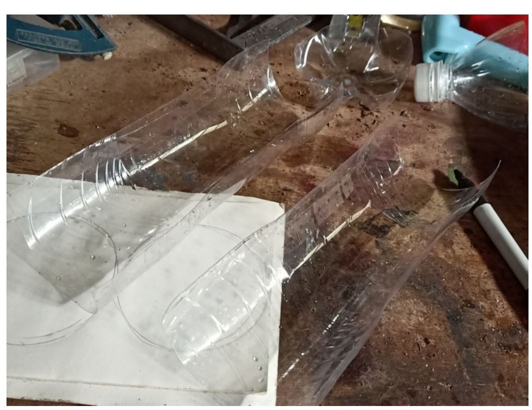
HAWT is the most commonly used wind turbine to generate electricity on a large scale whereas VAWTs are used to power individual homes. The HAWT has blades with an aerodynamic design that produces lift force which turns the rotor. This rotates the generator shaft and drives the generator to produce electricity. HAWT is installed with the rotor in the direction of the wind.

The main parts of a wind turbine are the rotor, gearbox, and generator. How to build a wind turbine for your science fair? Building a simple model VAWT is explained below.

Building a Model Vertical Axis Wind Turbine (VAWT)

- The blades can be made from a 0.5L to 2L Plastic beverage bottle carefully cut in half, lengthwise. Bottles that are approximately the same diameter for the entire length are best.

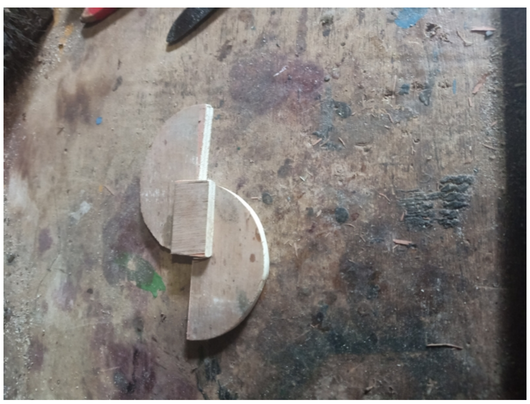


- Heavy cardboard or a piece of thin plywood can be used for the blade connectors. It should be cut into a circle the same diameter as the bottle, and then cut in half. Two sets of them are needed.



- The two halves are then aligned as shown in the picture with an offset of 1/2 of the diameter to expose the blades (bottle halves) to the wind. Glue (wood) or tape (cardboard) them well, and make a small hole for the rotation support rod to go through. A small, thin strip of wood may be glued to the two pieces (before drilling a hole) to give the connector more structural strength.




- The rotation support rod can be made from a wooden dowel, about 1/4” to 3/8” diameter and long enough to extend at least 2-3 inches from both the bottom and top of the turbine, as shown in the picture. Insert it into the connectors *before* glueing them to the blades to ensure correct alignment. An off-center line through the turbine will not turn well.


- The bottle halves are then glued to the connectors, top and bottom, as shown. Hot-melt glue may work better than either wood glue or rubber (contact) cement. A base block of wood (solid or 3/4” plywood) 12” x 6” can be used for the assembly base. Cut pieces of wood or dowels can be used for the overhead support frame.

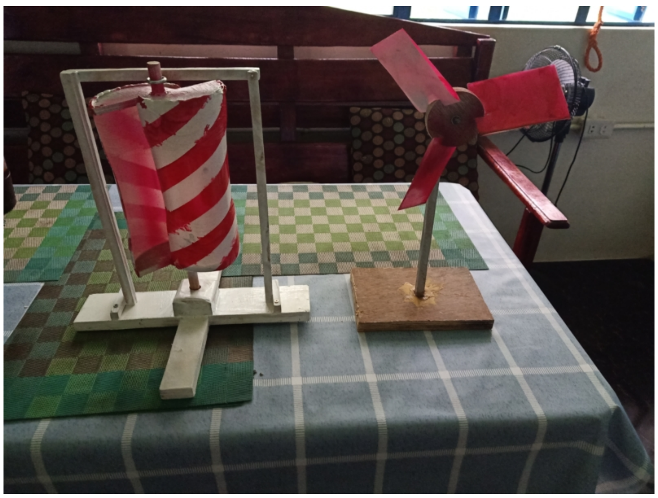
- It is very important to ensure that the overhead support frame and the center shaft are perpendicular and in the same plane to avoid off-center rotation and failure. I built mine to accept screws into the baseplate to allow for a final alignment of the shaft before fixing the frame to the base.

- A small hole can be drilled in the base for the bottom of the turbine shaft, and either an “eye-screw” can be used for the upper shaft support or you can drill another hole in the support frame top bar. The use of the eye-screw will make it easier to mount the turbine and make any alignment adjustments that might be necessary. I varnished my shaft and bottom hole to allow the use of light oil in the well to reduce the friction of turning.

- This completes the model. A working turbine would be connected to a generator or pump for electricity generation or water pumping, using the rotational energy from the turbine to operate the utilities.
- Painting the HAWT is optional, but it can show the rotation of the turbine better.

- You should be able to put the turbine in any windflow (or a fan, for a demo) in any direction to show how the VAWT design doesn’t need special alignment with the wind direction, as HAWT ones do.
- I added a simple HAWT model for comparison. A simple commercial toy pinwheel would also work for a science project display.




See the video VAWT vs HAWT Demo.mp4 for an active demonstration.

Variations

You can improve the rotation by reducing the friction of the shaft in the support hole. One way to do that is to make the hole a little be deeper and then add a “baseplate” to the shaft (shown in the picture). Under the baseplate you put a small rail circle smaller than the baseplate diameter (from cut wood, cardboard, or a piece of thin metal strip). Put some marbles (same size!) in the enclosed rail to create a ball bearing surface for the shaft baseplate. The shaft must still be in the alignment hole, but NOT touching the bottom. Other arrangements of bearings can also be used.

A commercial pinwheel toy or a simple horizontal axis fan can be used to demonstrate the omnidirectional advantage of the VAWT over the HAWT by placing them both in a windstream at various angles.