PVC Wind Turbine Assembly Guide

KidWind® PROJECT

This guide was created in collaboration with the Wright Center for Science Education at Tufts University, National Wind Technology Center, and the Department of Energy.

Firefly class pack | Mini mill | Basic | Advanced

Materials

For a classroom of 25 kids, we recommend having at least three turbines for blade testing. Below is a parts list for this wind turbine.

PVC PIPE FITTINGS

Head to your local hardware store for PVC pipe and fittings. KidWind also gets fittings from www.PlumbingStore.com. All pipes and fittings are 1". This turbine has:

- (5) 1" PVC 90° Fittings
- (3) 1" PVC T Fittings
- (5 ft) 1" PVC Pipe
- (1) 1" PVC Coupler

DC MOTOR, WIRES & CLIPS

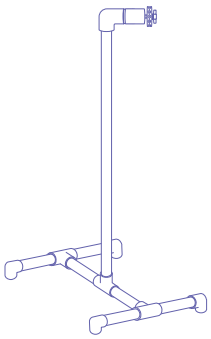
A local electronics shop will have wire, clips and multimeters. There are also a variety of online vendors. You can use any small DC motor as a generator. We carry the motor you would need at KidWind. However, if you spin any motor with your fingers and get a measurable output, it's a good generator.

- (1) Motor
- (4 ft) 22 Gauge Hook Up Wire
- (2) Alligator clips
- (1) Simple Multimeter to Record Power Output

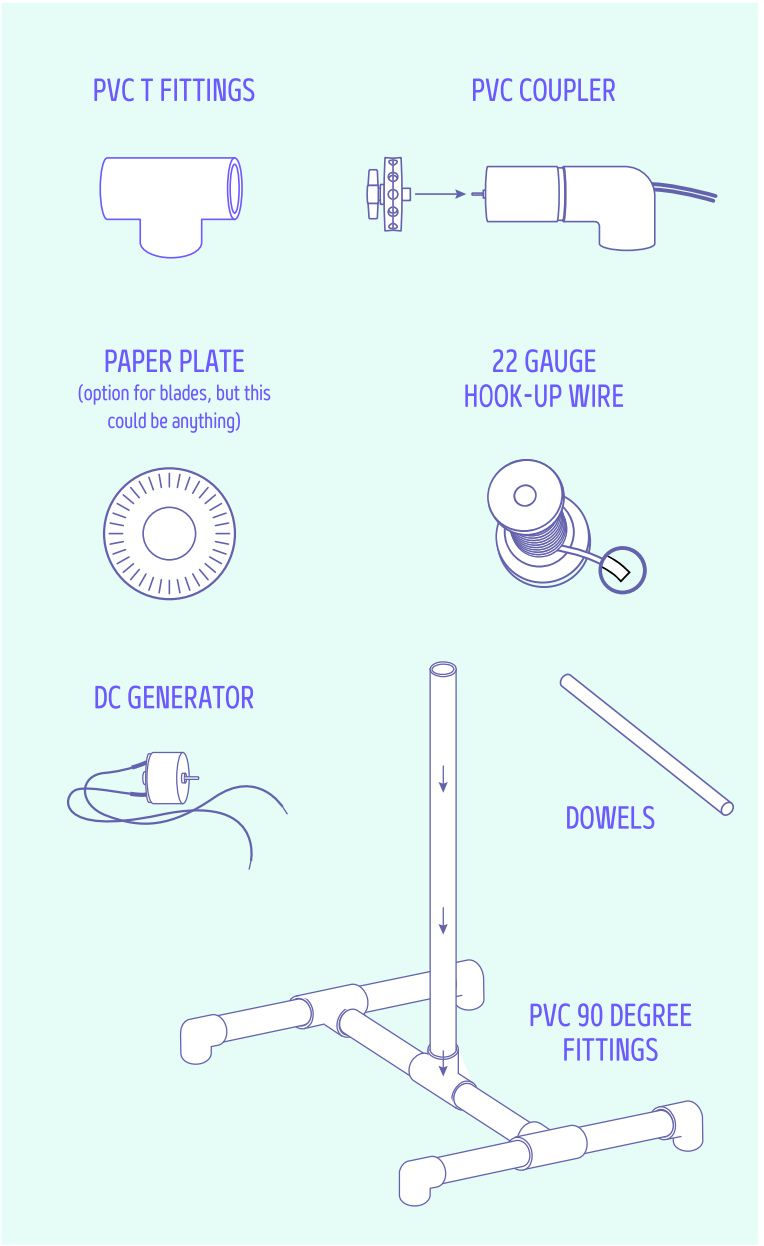
SPECIAL PARTS

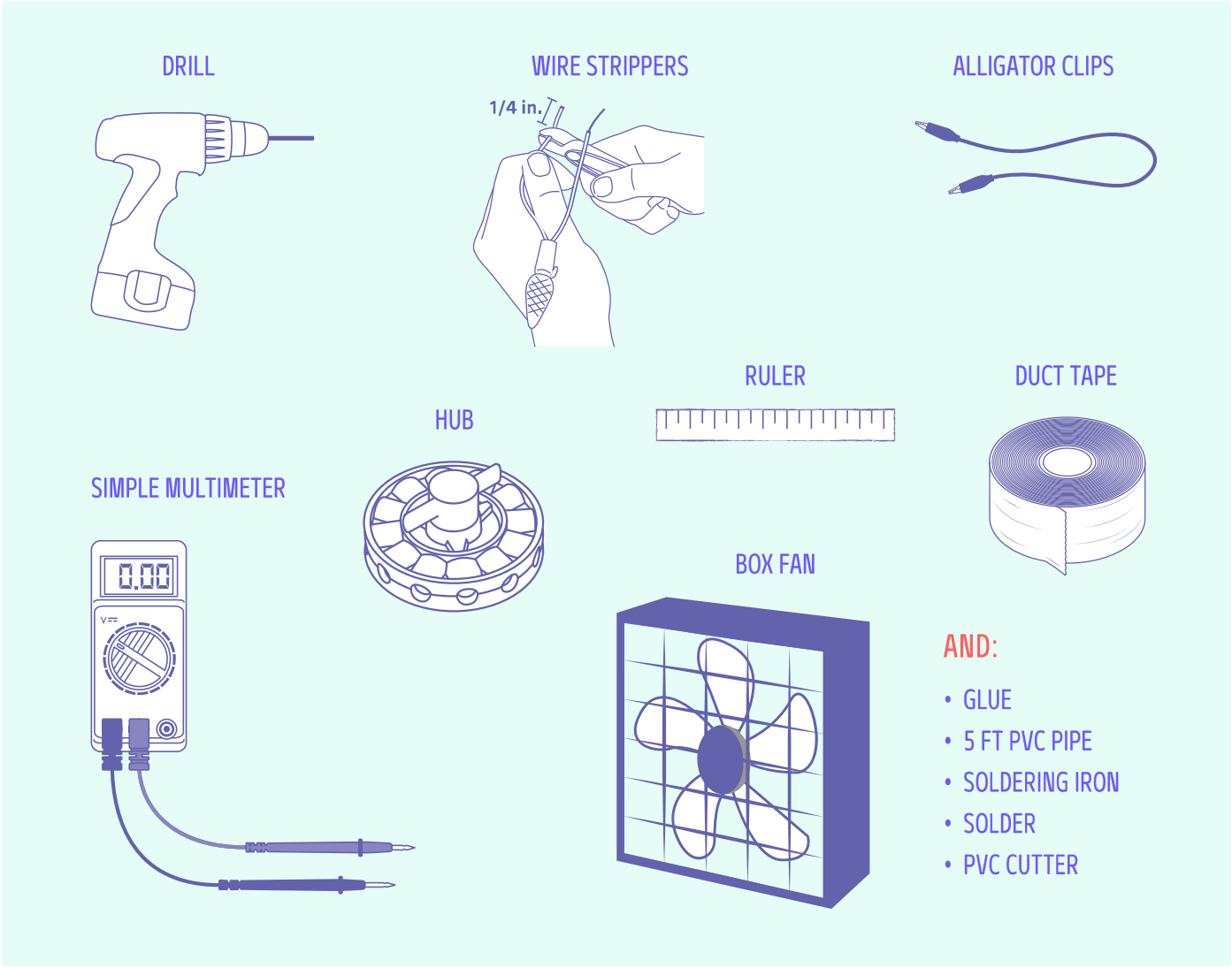
KidWind custom builds hubs for our turbines. For years we used to fashion our own hubs from Tinkertoys. If you want, head to your local toy shop or an online vendor to get yourself a barrel of Tinkertoys. A small junior barrel will run around $20 and has plenty of materials for 10 turbines. When you want something sturdy and tested come to Kidwind.

- (1) Hub (Crimping Hub from Kidwind, Tinkertoy or a round piece of wood to attach blades)



Safety note: Always wear safety glasses when the rotor is spinning! You could be hit if our blade flies off during testing.





BLADE MATERIALS

You can make blades, out of a variety of materials— wood, cardboard, felt, fabric. Students have made blades out of styrofoam bowls, pie pans, paper and plastic cups. Anything you find around the classroom can be made into blades!

→ (1 pack) 4" dowels 3/8" dia. (or Tinkertoy rods)— attach blades that you make to this.

TOOLS

To build this turbine from scratch you'll need at minimum a drill, PVC cutter or hacksaw, wire strippers, soldering iron, solder, duct tape, ruler, and glue.

Learning Goals

The goal of this resource is also to introduce students to the world of wind energy in a hands-on approach. Students will learn how to make a wind turbine out of PVC pipe, and understand how parts of a turbine work together to harness electricity from wind. This activity teaches resourcefulness and acts as practice for building more advanced turbines.

Getting Ready

- Consider trying to build your own PVC turbine before the class begins. This is a valuable preview to the challenges and problems that students may face.
- Gather the materials needed for this activity, and acquire any tools you do not already have. Separate the materials to distribute to the class or groups.
- Jog your memory on wind energy basics. Consider giving your students a brief intro to energy basics and how wind turbines harness that energy.

Activity

Go over vocabulary listed at the end of this guide with your students. Ask some preliminary questions:

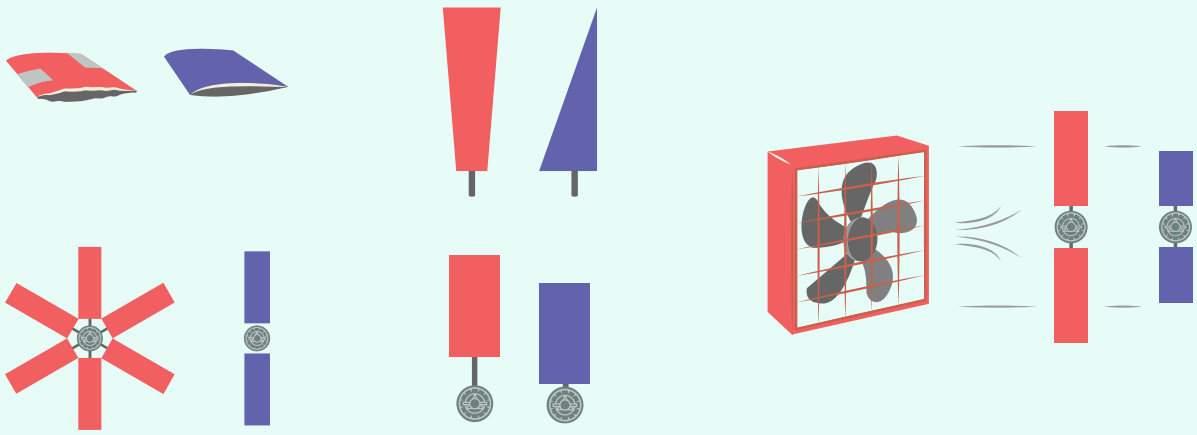
- Who has seen a windmill/turbine? Where?
- What are the parts and features of a turbine?
- How do wind turbines work?
- Why are wind turbines important?

Building the Basic PVC Wind Turbine

This is the first wind turbine developed at KidWind. The idea was adapted from a design we found at the www.otherpower.com website.

Rugged and cheap to build, this device will allow you to perform a variety of experiments and wind demonstrations quite easily.

These instructions will show you how to build this PVC turbine, how to make blades for your wind turbine, how to use a multimeter to record electrical data and some basic wind energy science.



Building the Basic PVC Wind Turbine

This is the first wind turbine developed at KidWind. The idea was adapted from a design we found at the www.otherpower.com website.

Rugged and cheap to build, this device will allow you to perform a variety of experiments and wind demonstrations quite easily.

These instructions will show you how to build this PVC turbine, how to make blades for your wind turbine, how to use a multimeter to record electrical data and some basic wind energy science.

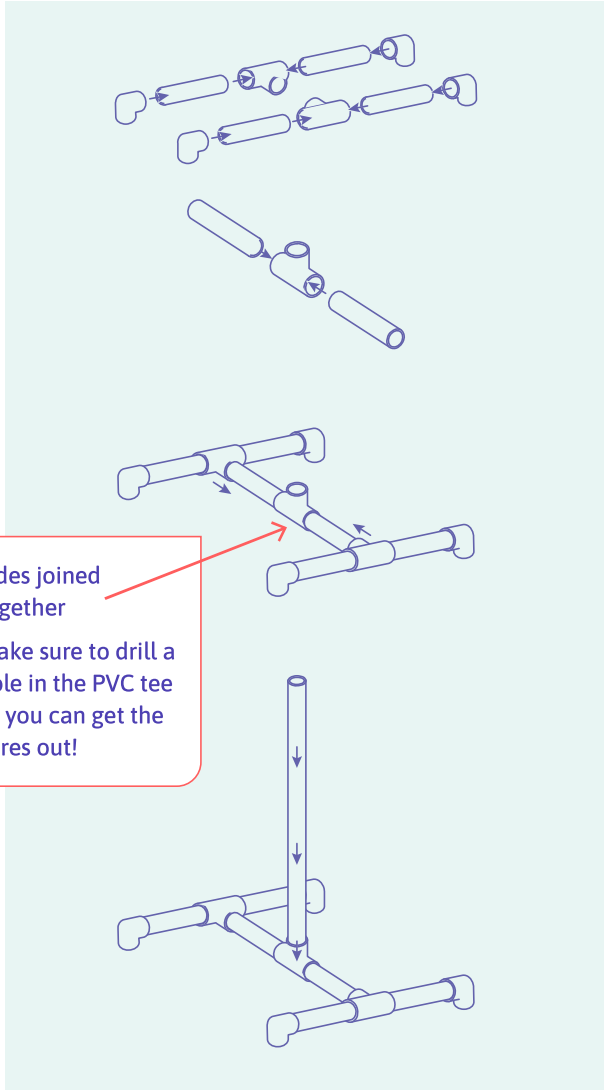
STEP 1:

Building the PVC Tower Base

1. Using (4) 90° PVC fittings, (2) PVC tees and (4) 6" PVC pipe sections construct the two sides of the PVC turbine base. Make sure in this step to use the PVC tees that DO NOT have a hole drilled in them.

2. Fit the parts together without using glue (PVC glue is really nasty stuff). To make them fit snuggly, tap them together with a hammer or bang them on the floor once assembled. (2) Identical Base Sides

3. Next connect the two sides using the PVC Tee with the hole. The hole will allow you to snake the wires from the DC motor out.



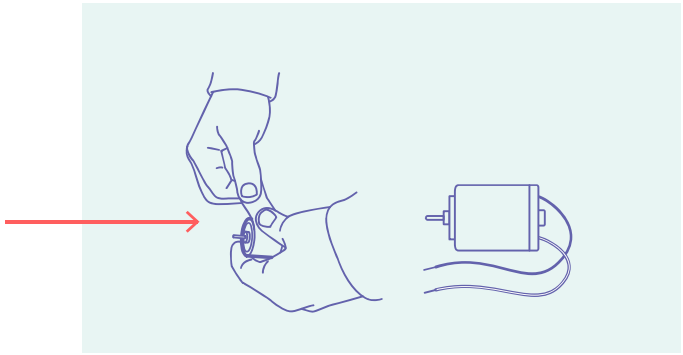
STEP 2:

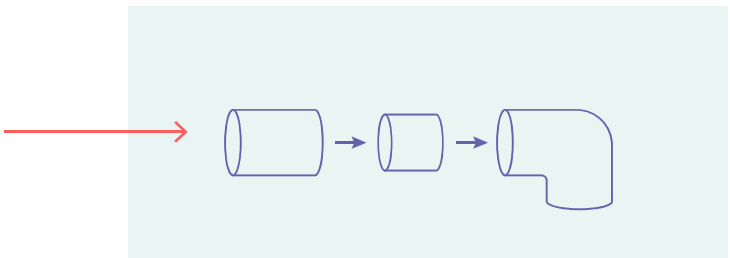
Building the Rotor & Hub

1. You will need to solder some wires (4' long) to your DC motor. Wrap a piece of duct tape around the outside of the motor. This piece of tape should be about 1/2" wide and 18" long. This will help the motor fit securely into the PVC coupler.

2. For this step use (1) PVC 90° fitting, (1) PVC coupler, (1) 3" piece of PVC pipe and the DC motor. The best DC motors will be close to 1" in diameter so they fit tight in the coupler.

3. Arrange the pieces as they look in the image to the right. Push them together to form a solid piece. On a large wind turbine this is called a nacelle; it holds the generator, gear boxes, and other equipment.



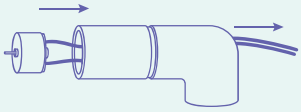


4. Insert the wires attached to the DC motor through the nacelle. They should come out of the 90° PVC fitting. The motor will rest in the coupler.

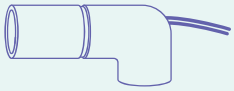
5. Insert the motor into the coupler. It should fit very snuggly. If it is too loose or tight adjust by wrapping or unwrapping duct tape around the outside. As the motor is pushed on frequently by students, it must be TIGHT! You can glue this in to make it secure.

6. Insert the motor making sure that it is straight and not too far in. If it looks cockeyed, straighten it out as it will cause your hub and blades to wobble while spinning.

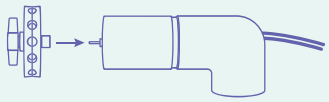
7. Once the motor is secured attach the hub you have decided to use. Press the hub onto the drive shaft. It should fit very snuggly.



Make sure the wire comes out the bottom!



Motor secured into the coupler. Straight!



Nacelle complete.

STEP 3:

Attaching the Tower to the Base

1. Snake the motor wires down the tower and through the hole in the PVC tee at the base of the wind turbine.

2. Attach the nacelle to the top of the tower.

3. Insert the bottom of the PVC tower into the tee at the center of the turbine base.

4. It should look just like the wind turbine to the right!

5. Assure that the PVC pipe is seated tightly into the fittings by tapping together with a hammer or by banging on the floor.

6. Do not use any glue so that you can take it apart and store it once you are finished.

7. Attach alligator clips to the wires coming out of the turbine to help to hook your turbine up to a multimeter!

SUCCESS!! Wind Turbine Completed!

STEP 4:

Blade Design

1. To make blades, carve or cut different shapes and sizes out of a variety of materials (wood, cardboard, felt, fabric) and hot glue or tape them to the dowels. Students have made blades out of styrofoam bowls, pie pans, paper and plastic cups. Anything you find around the house or classroom can be made into blades!

2. Before testing, check that the blades are securely attached to the dowel. If not secured properly, they may detach or deform as you test your turbine in high winds. We recommend using a combination of tape and hot or regular glue.

3. Insert the dowels into holes on the crimping hub. It is important to tighten the hub when inserting the blades so that they do not come out at high speed.

4. When attaching the blades to the hub consider a few important questions;

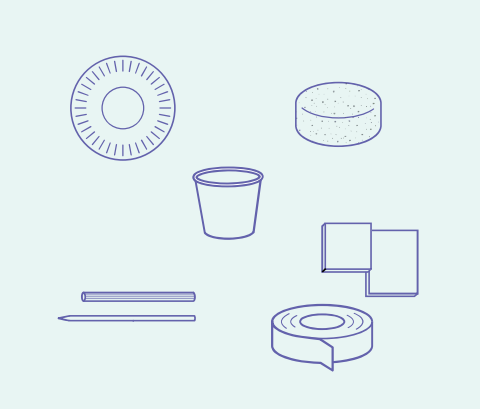
- → How close is the root of your blade to the hub? What do you think is optimal?
- → Are your blades about the same size and weight? Blades that are not balanced will cause vibrations that can reduce the efficiency of your turbine
- → Are the blades equally distributed around the hub? If not you can also have a set up that is out of balance.
- → Have you secured the hub after you inserted the blades? If not they can fly out at high speed!
- → Want to know how fast your blades are spinning then get one of these—Hangar 9 Micro Tachometer.

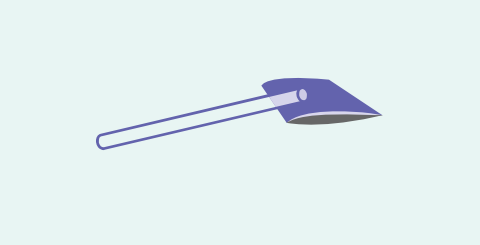
CAUTION

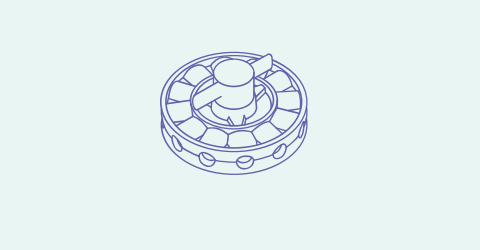
Never make blades using metal or any sharp edged material as these could cause injury during testing. Blades tend to spin very fast (400-600 RPM) and they can easily cut people if they have sharp edges.

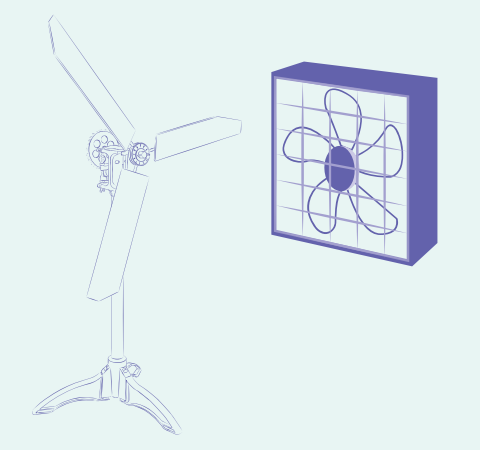
Again, DO NOT USE sharp metal or very hard plastic to make blades as blades can spin at very high speed (500RPM) and could cause injury.

Note: Learn more about blade design from our WindWise Lesson "How can I design better blades?"









STEP 5

Setup for Testing
Safely set up your testing area like the picture below. It is important to clear this area of debris and materials.

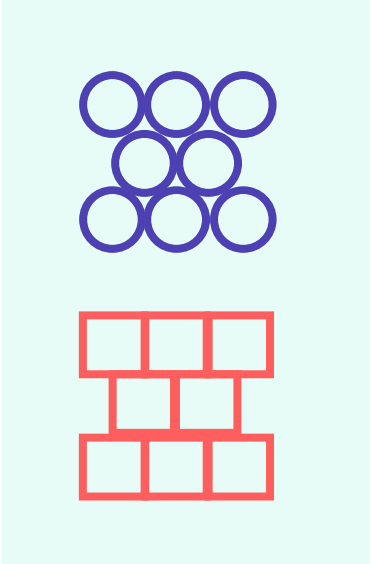
Stand In Front or Behind Turbine Make sure the center of the fan matches up with the center of the wind turbine. You may need to raise your fan with some books or a container.

Some things to note about fan wind that reduces the efficiency. Fans create;

- Highly Turbulent & Rotational Wind— Blades may spin better one direction than another
- Highly Variable Wind Speed -Wind speed is about 10-13 MPH on high for a $20 circular fan. Wind speeds near the middle will be much different than the edges.
- Limited Diameter— Blades bigger than fan will not "catch" more wind—they will just add drag and slow down your blades.

How to Clean Up Wind?

Want some more "professional wind"? You can try to build a simple wind tunnel. Lots of plans can be found online (search term:classroom wind tunnel) and at www.kidwind.org. One simple way to make more laminar—smooth, straightened—flow is to build a honeycomb in front of your fan using milk cartons, 2" PVC pipe or some other material.



Going Outside?

While you can use your wind turbine outside, you must make sure that you face it into the wind. This is because this turbine is not designed to YAW (or rotate) to face the wind. If the wind shifts, and the turbine cannot rotate, winds will hit the blades from the sides causing stress and inefficiency.

If you want to measure your wind turbine's power output for blade optimization, check out KidWind's Performance Calculator Guide.

CAUTION

NEVER make blades using metal or any sharp edged material as these could cause injury while spinning fast during testing.

VOCABULARY

GENERATOR
A generator is made of magnets connected to a shaft and conductive wire. When magnets are moved next to wire quickly, an electrical charge is generated that can power things like lights.

FORCE
Force is a push or pull.

FRICTION
Friction is the “pull” of a force. Friction is a force that resists the relative motion of two things in contact.

MOTION
The action or process of something moving or being moved. Wind is air molecules in motion. Wind acts as a force on the PVC turbine blades, causing them to move in rotation.

WIND TURBINE
A wind turbine is a human-made device that is designed to spin in the wind in order to generate electricity. Our PVC turbine spins and generates electricity that can be harnessed.

HUB
A hub is the central component connecting the blades to the generator shaft.

BLADES
The blades on a wind turbine are the parts that spin because of the way they catch the wind.

PLANE OF ROTATION
The plane of rotation is the area directly in line with the rotor. It is dangerous to stand in this area because a blade that is not securely fastened to the hub and detaches could hit a person standing in this zone.

BLADE PITCH
Blade pitch is the tilt or angle of the blades in the wind, with respect to the plane of rotation.

DRAG
For a windmill, this is also called wind resistance. Drag is the friction of the blades against air molecules as they rotate. Drag works against the rotation of the blades, causing them to slow down.

Questions? Scan this QR Code to view our Wind Turbine FAQ

SCAN ME