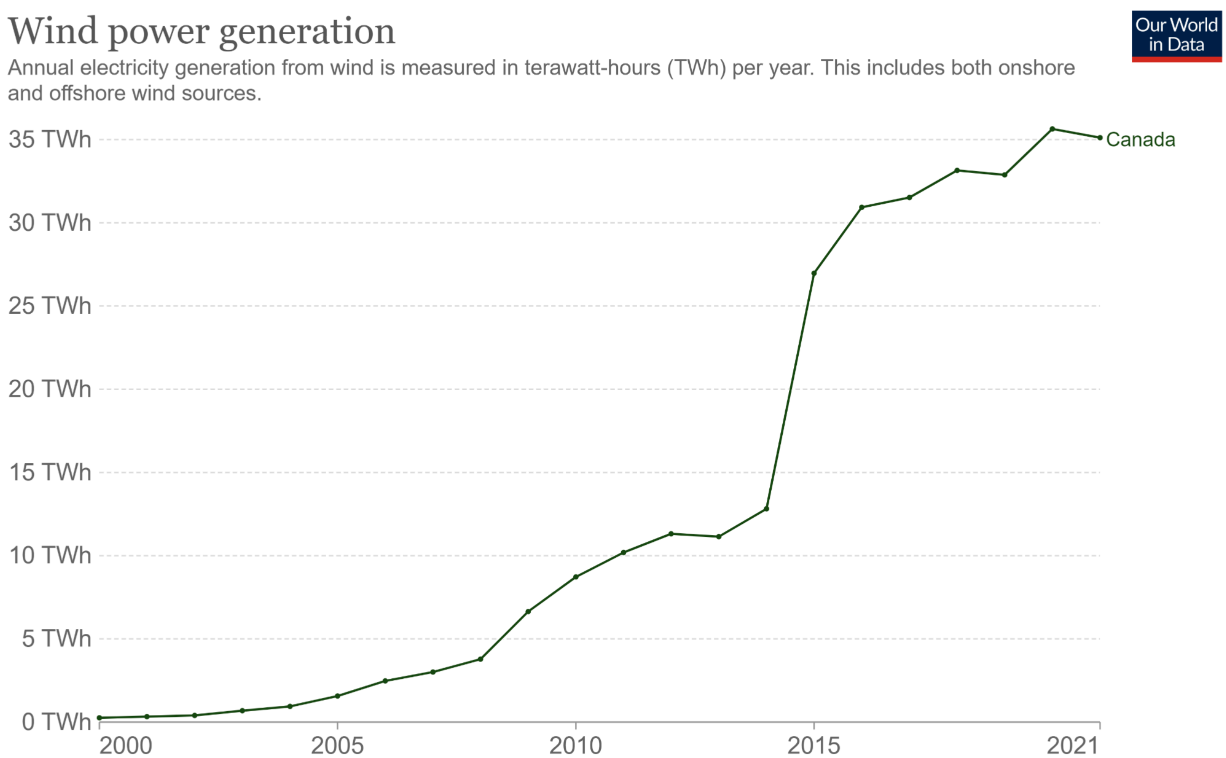
(604) 432-4229
www.skillscanada.bc.ca

Model Wind Turbine Competition

Grade 6-10 Students

1. Overview & Purpose

Relying on fossil fuels for the last century has created a climate crisis that is forcing us to change how and where we live. As the world population continues to grow and require energy, we need to find a way to generate energy without further contributing to CO2 emissions. Using wind as a source of energy has grown considerably across the globe (US and China in the lead) and in Canada.



Source: Our World in Data based on BP Statistical Review of World Energy (2022); Our World in Data based on Ember's Global Electricity Review (2022); Our World in Data based on Ember's European Electricity Review (2022)
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In this challenge, you and your team will design, build, and test a wind turbine system that collects as much energy as possible from a steady stream of air generated by a fan. The more efficient your design, the better!

2. Wind Turbine Physics

2.1 Energy

When an object moves, it has kinetic energy. We know it is energy because it can do work. A moving hammer, for example, can hit a nail and drive it into a piece of wood–that's work. Air has mass, and when it moves, it has kinetic energy. In some ways, wind is like billions of microscopic hammers, hitting our turbine blades and making them spin. Kinetic energy comes from two things: mass and speed. We cannot do much to change the mass of air, but the more air we intercept, the more kinetic energy is available. If we double the amount of air we intercept, we double the energy. The speed of air makes an even bigger difference! If we double the speed of the air, it quadruples the amount of energy. In the competition, the speed of the air will be the same for everyone.

2.2 Turbine Blades

The design challenge in this competition is the blade design. It is not easy to understand how blades work, but a start is to think of holding your hand out of the window of a moving car (which you should never do, of course). The angle and shape of your hand changes how hard the wind pushes on it. If you can think of your blades like that, it is a good start. A harder but more realistic idea is to think of a blade like a wing (on a plane or sailboat). Air flowing over the wings of a plane give them "lift" and allow them to fight the pull of gravity. The "lift" on turbine blades is designed to turn the rotor instead. If we believe that, then we have to consider–what shape, how many, and where should we put them? There is a lot on Youtube about this idea.

2.3 Gear Ratio

Energy is produced by rotating the generator shaft of our hobby motor. Choosing different combinations of gears can increase the rotation speed but makes it harder for the wind to spin the blades. You will have to find the trade off that works best for your blade design! During testing, you will have a choice of two gearing ratios, 8:1 or 4:1

2.4 Efficiency

Making real wind turbines is an expensive business, so we want them to be as efficient as possible. Efficiency is how much of the available wind energy is collected compared to what is available. For example, if 100 Joules of energy was contained in a moving parcel of air, and you collected 35 Joules as it went by, your system would be 35/100 = 0.35 = 35% efficient.

In summary, we want a blade design that captures as much high speed wind as possible and creates the fastest possible rotation of the generator shaft!

3. Competition Rules

3.1 Eligibility & Teams

To compete Provincially, you must first compete locally. The winning team from a regional competition is eligible to register in the Provincial Competition. Once all the regional gold medal teams are registered and if space is available then teams will be accepted on a first-come, first-serve basis. Extra teams will be placed on a waitlist and will be notified if there is space available.

Teams may consist of up to 4 students in grades 6 – 10 from the same school.

Each team must have one teacher/advisor.

Check the website www.skillscanada.bc.ca in February of any year for details on registration.

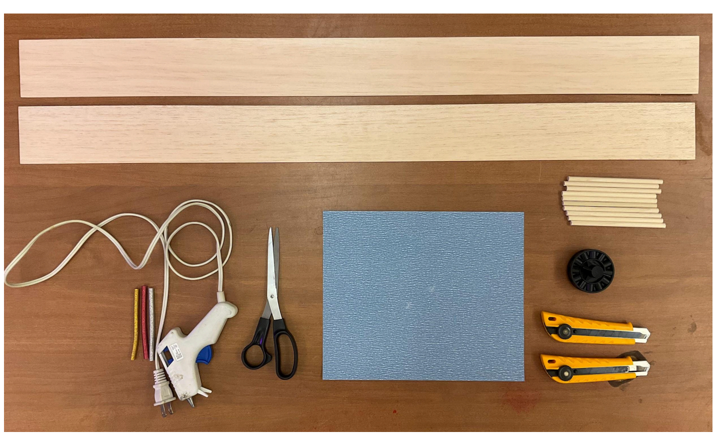
3.2 Competition Day

Teams will be given specific materials to construct the wind turbine and will have approximately **2.0 hours** of building time at the competition site. You can practice with a kit and bring design sketches, but your wind turbine system will be built on-site with a new set of materials, not pre-built.

3.2.1 Materials

The following items ***will be supplied by the sponsors*** for wind turbine construction on the day of competition:

- 2 of 4"x 36" x ⅛" Balsa wood
- 2 utility knives
- 1 hot glue gun and 5 glue sticks
- 1 sheet of 120 grit sandpaper
- 1 pair of scissors
- 10 Wooden dowels
- A central hub for the dowels

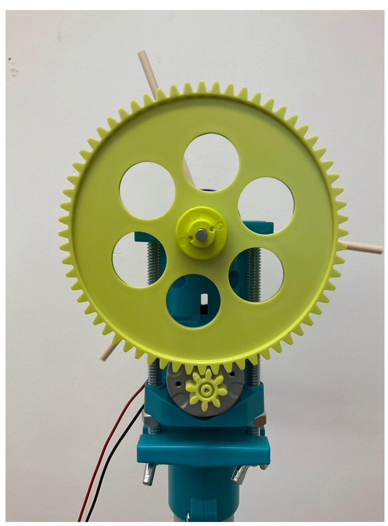


3.2.2 Testing

The goal of the testing is to generate the most power possible in a fixed air stream (~1100 CFM) generated by a standard 20” box-fan. When it is your turn, a judge will help you with the following steps:

1. Bring your design to the judge for weighing in (for tie-breaking, lightest wins)
2. Choose a gearing ratio, either 8:1 or 4:1
3. Mount your blades and hub onto the wind turbine tower.
4. One of your blades needs to start pointed downward in the lowest energy position.
5. Turn on the fan and take power readings for one minute.
6. Turn fan off and move on to the next team.
7. Repeat the test once everyone has had a first trial. Best of the two trials will be used in judging.

The model turbines will be judged by the wind-capture power-generating capacity, using the formula P = V x I where V = voltage and I = current as measured by a Vernier Energy Probe. Where a tie occurs (results within 5%), the *lighter design* will be considered the winner. Judges’ decisions are final.


3.2.3 Recommended Schedule for the Day

- 9:00am - 9:30am Registration//Instructions/Kits Provided
- 9:30am - 11:30pm Turbine Blade Construction
- 11:30pm - 12:30pm Lunch (provided)
- 12:30pm - 1:30pm Testing of Designs
- 1:30pm - 1:45pm Final Tally of Scores
- 1:45pm - 2:00pm Awards Ceremony

4. Advice for Teachers

Copies of the kit can be sent to your school before the competition so that your teams can practice. The box fan was chosen because of its ubiquity–it should be easy to find one and do some testing at school before the day-of.

The load on the Vernier Sensor has been tuned to match the impedance of the 3V DC hobby motor under ideal power capture circumstances–we found this to be in the range of 30-40 Ohms. This allows the maximum amount of power to be transferred from the motor to the sensor. If you don't have the Vernier Probe mentioned, you can just use two multimeters–one for voltage and one for current and multiply the readings to calculate power using the formula:

$$P = V \times I$$

The competition is an assessment of what they know about wind turbines when they arrive. In fairness to all teams, support your students without giving technical advice on the day of the competition.

Blade design is complicated and your team's best chance of success is to try out different number of blades, orientations, and shapes before they come to the event.

Questions?

Mike Hengeveld
Templeton Secondary
604-713-8984
mhengeveld@vsb.bc.ca