KidWind Competition Rules

Who Can Participate?

Event Competition

Any group of students in grades 4 to 12 is eligible to enter a team in a KidWind Competition Event. This includes students from public and private schools. As long as you have a coach (teacher) and a team, you can attend! There is a restriction of 4 members on a team. Each team must have a coach. The coach (teacher) will be responsible for registering the team for the competition and managing the team's progress. The Cradle of Aviation is not responsible for supervising students at the Competition. We require teams to make sure that there is one adult for every ten students who attend a Challenge.

What Does the Event Look Like?

Food

We do not provide food for this event. Students must bring their own lunch on the day of the event. The Cradle will provide cafeteria space and a scheduled time for lunch. The Museum has a cafeteria where students may purchase food, but it is highly recommended to bring their own lunch.

Supervision

We ask that coaches (teachers) bring their teams to the competition and that they bring one adult supervisor for every ten participants.

Sample Schedule

Time	Activity	Description
9:45 am -10 am	Arrivals & Set-up	Typically your team will arrive at a KidWind Challenge and be given a table or space to set up your turbines/or solar device. As your team checks in, we will usually distribute any materials needed. At most Challenges, we will have the wind tunnel out so students can make any final tweaks to their projects and will provide a tool area so that they can make any last-minute repairs. The Cradle of Aviation does not provide tools.
10 am	Announcements & Introductions	At this time, we will convene the teams, introduce the judges, and give participants an

		idea of how the day will progress.
10 am – 12:30 pm	Turbine and Team Evaluation	Although the exact time of the overlapping events depends on how many teams arrive at a Challenge, this generally takes two to four hours. Many different events take place during this time. Teams are typically assigned times for each event to make sure they accomplish each task.
12:30 pm	Evaluation Events Completed and Judges Tabulate Scores	
1:00 pm	Results and Prizes Announced	
1:30 pm	End of Competition	

Participant Checklist

- ☐ Learn about the basic parts of a wind turbine
- ☐ Get some turbine-building gear
- ☐ Build a turbine
- ☐ Test and improve your turbine
- ☐ Collect some data about your turbine to share with the judges (notebook, video, etc.)

What do I bring to the Challenge?

- Turbines
- Wind Project Profile Form
- Extra Parts, just in case
- Tools, just in case
- Pen/Pencils
- Lunch
- Water bottle
- Extra documentation for the Judges (poster boards, notebook, photos, ***PowerPoints are not permitted***)

WIND CHALLENGE DIVISION

There are three possible age division:

- ➢ Elementary Division (4-5th Grade) Only KIDWIND Generator
- ➢ Middle School Division (6-8th Grade)
- ➢ High School Division (9th – 12th Grade)

The generator your turbines use determines how we classify and evaluate your turbine performance in the wind tunnel. There are three classes of generators you can use:

- KidWind Generators
- Home-built generators (AC or DC)
- Advance Generators (AC or DC)

If you use a KidWind Generator, you will be placed in the KidWind division.

You will be placed in the Open Division if you purchase a generator.

You will be placed in the Homebuilt Division if you make your own generator.

Only teams participating within the same division will be competing against each other.

Equipment to Build your Generator

Whether you're building a turbine for the competition event, you will need some basic gear to get started KidWind.

Generators

Your team's generator determines how we classify and evaluate your turbine in the wind tunnel and compare energy and power generation. There are three classes of generators you can use.

KidWind Generator (KIDWIND Division)

The easiest path to get a few KidWind Turbine Generators is from Vernier. If you use this generator, you will be placed in the KIDWIND division. The day of the competition, we will have KidWind Turbine Generators ready to use to test your turbines.

Advance Generators (Open Division)

You can purchase a commercially sold AC or DC generator (not a KidWind generator) that better matches how much power your turbine can generate.

Homebuilt Generator (Homebuilt Division)

You can construct your own generator using a kit, online plans, or your own ingenuity. A home-built generator is defined as a generator where the students construct ALL of the major components of the generator. This would mean the students wind the coils, the stators, and other components have been

constructed, 3D printed or otherwise built by the team. This does not extend to this device's magnets or driveshafts or similar components.

The key to using a home-built or advanced generator is to ensure that the power output does not exceed 30V at 1A at any point in testing. You will also have to properly match a load to your generator for maximum efficiency. This can get complicated!

Before a KidWind Challenge event begins, ALL teams must declare the generator division in which they wish to participate (KidWind, Open, or Homebuilt). Judges will inspect your generator to confirm the division. Please make sure that your generator is visible.

Once a team makes their first wind tunnel run, they will be locked into the division they have declared. Turbines may be marked with colored stickers to indicate their generator division.

Blades

Wind turbine blades and their orientation to the wind are very important parts of a wind turbine design. You could study this for years and still not be an expert! The only rule we have about blades is you cannot use pre-made airfoils and your blades should be made of safe materials. We see students using all kinds of materials to make blades: cardboard, balsa woods, 3D.

Gear boxes or Belt Drives

While building a gearbox or a belt drive can be challenging, it can also greatly increase the power output of your wind turbine. Belt drives or gears can give your wind turbine a mechanical advantage and multiply the mechanical force of the turning blades.

Your team can use KidWind gearboxes and parts through our partners at Vernier, you can find parts from other vendors or construct your own gearboxes or belt drives. The only rule is that we must approve it as safe!

Towers

You can make a tower for your wind turbine out of practically anything. Check out these plans to make a simple PVC tower turbine or get a simple KidWind tower from Vernier.

Don't limit yourself to just these towers! In fact, if you want to win you will need to adapt! We have seen some great towers made from wood, cardboard tubes, Tinker-Toys, plastic, etc.

Try experimenting with different designs! Which type of tower seems strongest? Why do you think certain wind turbines use the type of towers they use?

The only rule for making your tower is that it must have a firm base to sit securely on the ground, and it must be tall enough so that your blades will not hit the ground. If your turbine has a gear or pulley system, you must have some kind of platform or housing on top of your tower to hold the gear/pulley box.

Fans or Wind Tunnels

You can use any fan to test your turbine. At KidWind Competition event, we will have a KidWind Competition Wind Tunnel (KW-TUN) or something very similar to test your turbine.

If you are handy, you can try to construct your own – many teachers have done this! Unlike a box fan, our tunnels suck the air through the shroud, leading to cleaner, less turbulent winds.

Power Measurement

You will need to learn how to measure power output from your turbine. You can use a simple multimeter or data-logging equipment. The key is to make sure that your turbine is attached to a load whenever you are collecting data. What's a load? Time to do some homework.

Power Conditioning

We will allow devices (buck-boost or other electronics) that reduce the output voltage and current from competing turbines to meet our 30V and 1A data collection limitations. We will not allow devices that increase the voltage or current from your turbine.

Turbine Design Rules

As you construct your turbine, please keep the following rules in mind:

1. Each team that registers must have its own turbine. You will not be allowed to modify another team's turbine and use it for testing. Teams cannot share one turbine and simply change blades or other parts for each team.
2. The turbine must fit inside the wind tunnel and operate within its 48" x 48" internal dimensions. It is HIGHLY recommended that you design your turbine to fit within these dimensions with plenty of room. Sand bags or other weights will be available to hold the turbine in place, but we have found that almost all turbines shake and move a little in the tunnel, so it is a good idea to have extra space!
3. There are no budgetary restrictions for your turbine design, but it is important to keep in mind that part of the judging process is the economical use of resources. Please use materials responsibly.
4. You may only use 1 generator per turbine.
5. Power must be generated solely by wind, using the wind tunnel.
6. Your turbine can be built on either a vertical or horizontal axis.
7. Your turbine may use a gearbox, pulley system, or similar mechanism to increase power output. You may use pre-manufactured gearboxes and other parts, but keep in mind that innovation is a critical judging criteria, and parts that you make on your own will earn you more points.
8. You cannot use pre-manufactured wind turbine blades or airfoils/sheets.
9. Your wind turbine must be free-standing. A tower/stand will not be provided.
10. Metal, plexiglass, and similar blade materials are highly discouraged because they are potentially dangerous. Please be aware that turbines will be disqualified if they are deemed unsafe by the judges.
11. The use of 3D printed parts and components is allowed. While you do not have to use files you created yourself, you should bring documentation about the CAD files to the Challenge and be prepared to discuss the design and the 3D printing process. Judges will want to make sure you understand this technology if you decide to use it.
12. Students have used wheels from bicycles as part of their turbines. These are allowed since bike wheels are designed to spin at high RPM. Please be aware that if the wheel assemblies appear unsafe, local judges will disqualify these turbines.
13. Shrouds are no longer allowed.

Connection and Loads

- You must have two wires at the base of your turbine. You must label which wire is positive and negative. Your turbine must produce DC power for our data logging system. If you make your own generator and it is generating AC power, you must rectify it to DC power.
- Teams that use KidWind Generators will be testing using a 30 ohm load.
- Teams in the OPEN DIVISION who construct their own generator or use an advanced generator are allowed to provide their own load during testing. They must provide the load and have it inspected by local judges. Teams may not use Maximum Power Point Tracking (MPPT) devices or variable resistors. Only static loads are allowed as the wind speed of the tunnel is not variable. You will be allowed to change your load between each test. You cannot change the load during a test. If you do not provide a load, your turbine will be tested at 30 ohms.

Power Output

- Our data-logging software and hardware can measure Direct Current at 30V/1A. Teams in all divisions must make sure to regulate their power output below these specifications. If your turbine exceeds this output, even for a millisecond, it will be disqualified as the equipment will not be able to properly record its power and energy output. This is very important!
- If your turbine produces so much power that it damages the generator before testing is complete, you will be able to retest your turbine as long as you can repair or replace your generator.
- If your turbine produces so much power that it damages the generator before testing is complete, you will be able to retest your turbine as long as you can repair or replace your generator.

Wind Tunnel

- Wind turbines will be tested in a 48” x 48” wind tunnel at a wind speed of approximately 3.5 to 5 m/s. Wind moving at 3.5 m/s within a space this large is much more powerful than a single box fan. Test your device for high winds! Watch for blade deformation or deflection and excessive torque on your gearboxes.
- All teams will be given time to tweak their turbine in the tunnel before actual testing begins. How much time will be determined by the type of event, number of entries, and free time available.
- Unlike a typical box fan, our wind tunnel sucks wind through it instead of pushing it. This creates a more powerful and consistent airflow to streamline testing. This should not affect the design requirements for your turbine.

Turbine Testing

- Once the testing session begins, you will be given two minutes to set up your wind turbine inside the tunnel.
- If you are using a KidWind Generator, the wires at the base of your turbine will be attached to a circuit with a 30 ohm resistor in series and will simultaneously measure voltage and amperage.
- If you are using a homebuilt or advanced generator, you will attach your desired load to the turbine or our measurement tools and then attach the wires at the base of your turbine to the circuit that will simultaneously measure voltage and amperage.
- In order to receive full marks for functionality, your wind turbine must be able to start producing power without external assistance once the wind tunnel is activated.
- Once your turbine is in the tunnel and connected to the data collection system, the judge will turn on the fans and ask your team if you want this test to count. If your team says yes, the judges will collect data on your turbine. If your team says no, you may remove your turbine, make a small tweak and try again. If there is a line of students waiting, you will probably need to head to the back of the line. This process will vary depending on the event.
- During testing, the wind tunnel will be running constantly. We will collect power and energy output data between 30-60 seconds. Your energy output source will be calculated using a Vernier data logging system that collects voltage and amperage readings simultaneously .
- If your turbine produces so much power that it damages the generator before testing is complete, you will be able to retest your turbine as long as you can repair your generator. If you are unable to record power and energy data with our equipment due to generators overheating, your turbine may not receive a power and energy score.
- Depending on your local Challenge rules, size, and time frame, you may have between 1 and 5 trials for testing, and only your best trial will contribute to your final score.
- Our judges have final say on rulings and disputes.

Defining Catastrophic Failure

An event that causes a turbine in the wind tunnel to produce zero power while collecting test data is defined as a Catastrophic Failure Event. This could be due to either a mechanical or electrical failure. If this happens, you will be offered the following options. You will either be given two minutes to set up

your wind turbine again, or you will be allowed to remove the turbine to make repairs. In the latter case, you will be moved to the back of the line for retesting.

Failures that lead to REDUCED performance are NOT considered catastrophic and a retest would not be allowed under these circumstances.

How Will Your Turbine and Team Be Evaluated?

At every KidWind Competition, teams can expect to be evaluated on the energy produced.

Energy Produced (30%)

The total energy output of your turbine over the 30 - 50 second trial period will be collected using data-logging software. Each team's energy output will be ranked relative to that of other competitors. Each team will receive points corresponding to its rank.

Energy scores will be ranked on a comparative basis using one of two methods:

Rank Method

Turbines will be ranked by energy output. The highest producing turbine will receive the full number of available energy points, the following turbines will receive points based on rank with a 2-5 points deduction for each position they are from the top turbine.

Example: The top turbine produces a total of 100J and receives 35 points. Your turbine is ranked 6th at 80J and each rank down receives 2 less points. You get 25 points.

Ratio Method

Turbines will all be ranked by energy output. The highest producing turbine will receive the full number of available energy points. All other scores are calculated based on the percentage of the top score.

Example: The top turbine produces a total of 100J and receives 35 points. Your turbine produces a total of 80J, so your team would receive 80% or 28 points.

In all cases, you want to generate as much energy as possible to get a high score.

Turbine Design (35%)

A panel of judges will examine your wind turbine design at a KidWind Challenge. This 15-20 minute interview is to get a better understanding of the process you went through as you designed and tested your turbine. You should be prepared to discuss/defend the choices you incorporated into the design.

Questions judges may ask about your turbine design.

- Does your turbine have a gearbox, a pulley system, or is it direct drive?
- Did you have any issues with friction? How did you reduce friction in your drive train?
- When building your turbine, what kinds of obstacles or challenges did you face?
- How did you balance your blades? Do you notice any vibration when your turbine spins up to speed?
- Why are modern wind turbine blades shaped like airfoils? Are your blades shaped like airfoils? Did you try to make any airfoils?
- How did you determine the number of blades you would use? Did you perform any experiments?
- How did you determine the pitch (angle) of the blades?
- Why are your blades as long as they are?
- What materials did you use to make your blades? Why? What was important as you were building your blades?
- What techniques did you use to increase the power output of your wind turbine?
- What materials did you use to make your tower? What were some of the challenges you faced making a tower?
- What changes did you make to your turbine that led to the most performance gains?
- Discuss the craftsmanship of your design, including creativity, economic, and environmental decisions.
- Did you use recyclable materials?

Written Documentation of Design (35%)

All students must complete a Project Profile Form. This sheet should be presented to your judges when you enter the judging room.

In addition to this sheet, teams may also share additional documentation with the judges that showcases, with more detail, their design process and knowledge of wind energy science. It is up to each team to determine how they want to document this part of their project. In the past we have seen:

- Short reports
- Engineer's notebooks
- Science fair poster boards