KidWind Challenge

KidWind Challenge GUIDEBOOK

2016 EVENT RULES

KidWind Challenge Advisory Panel

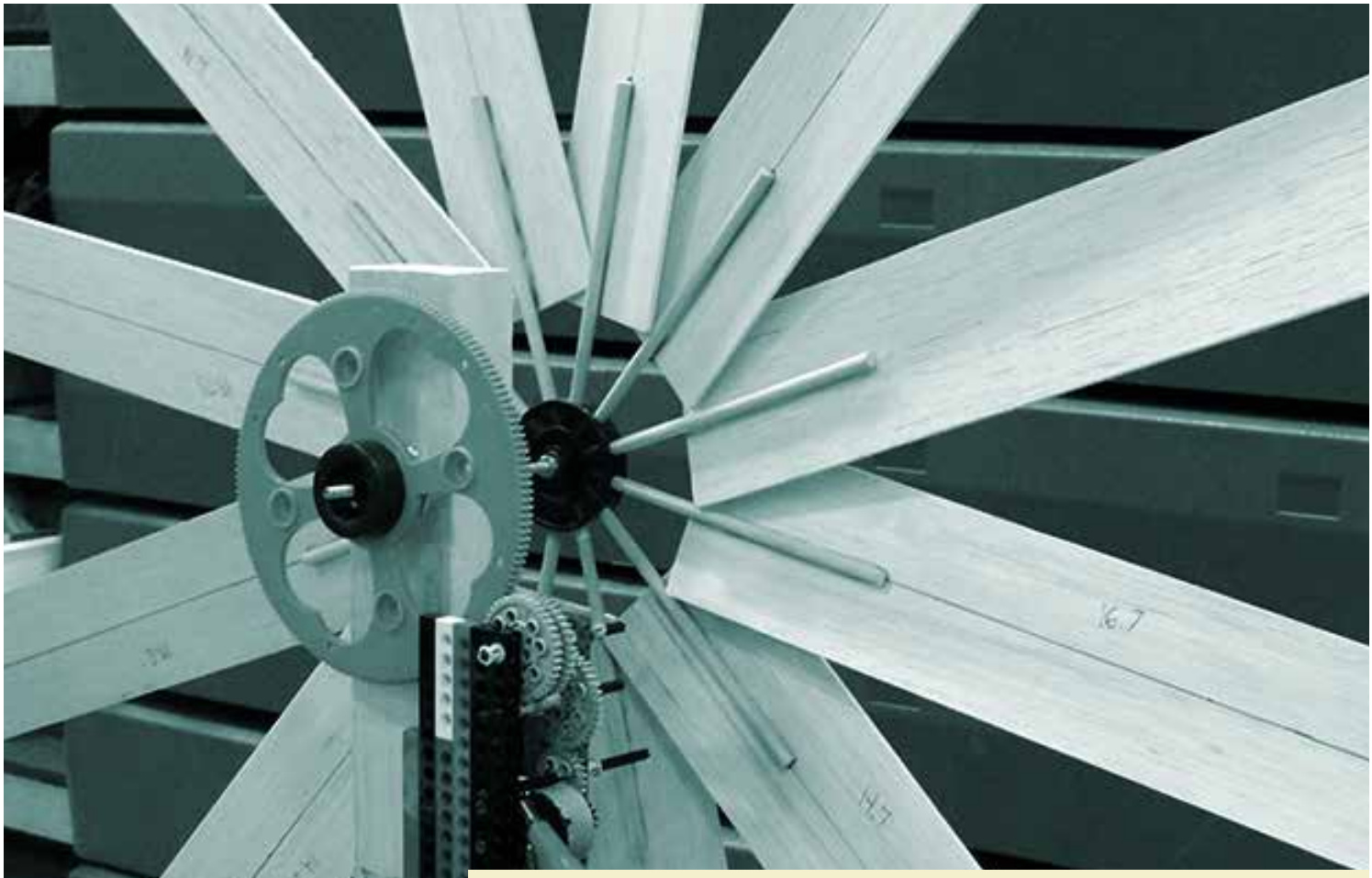
We would like to thank the KidWind Challenge Advisory Panel for their past and continued service in helping KidWind go further than we ever thought we could. Here's to a bright future powered by renewable energy.

- **Tara Chklovski** Founder/CEO, Iridescent
- **Bob Bechtold** Founder/Owner, Harbec Plastics
- **Larry Flowers** Distributed Wind AWEA
- **Kristen Graf** Executive Director, Women of Wind Energy
- **Andy Lueth** WindSenator/Teacher Buffalo
- **Cheryl Moeller** Executuve Director, High Tech Kids
- **Charles Newcomb** Director Technical Strategy, Endurance Wind Power
- **Joseph Rand** Former Director KidWind Outreach & Training
- **Darlene Snow** Executive Director, Wind Energy Foundation

Sponsors

While KidWind self-supports a number of Challenge events around the country, our impact would be limited without grants and sponsorships from renewable energy industry organizations and foundations. We are actively seeking additional sponsors to help us engage more students. Sponsoring a KidWind Challenge demonstrates an investment in the workforce of our clean energy future. We invite you to share in our passion to inspire these future leaders, engineers, scientists, innovators, and problem-solvers of our energy future. For a full list of sponsors please see http://challenge.kidwind.org/events/sponsors.

A Note on Reproduction



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Who is KidWind?

The KidWind Project is a team of teachers, students, engineers, and practitioners working to make wind and other renewable energy education accessible in classrooms around the world. Our goal is to engage minds in hands-on activities which are exciting and challenging to teach basic science and engineering principles.

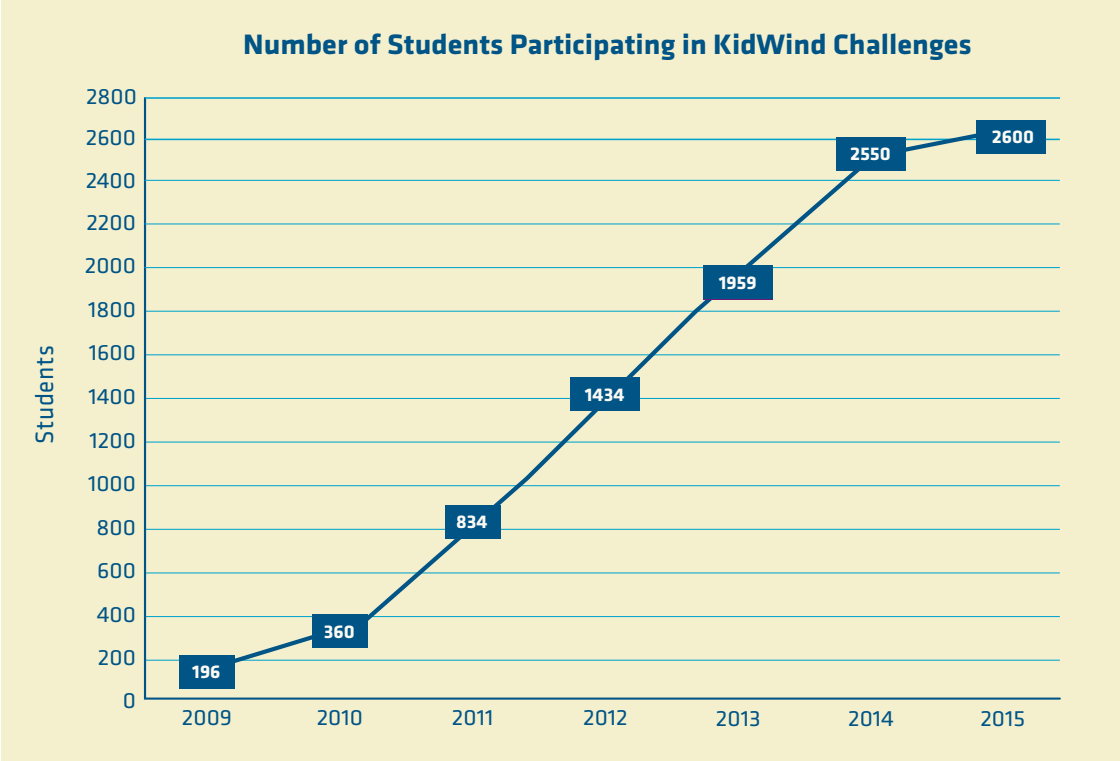
Founded in 2002, KidWind has established itself as a leader in renewable energy STEM curriculum and teacher training throughout North America. We have also held teacher workshops in Costa Rica, Chile, Ireland, Taiwan, and the Caribbean. We have trained over 10,000 educators through professional development workshops, and these teachers have impacted over 800,000 students annually. Our formal, standards-based curriculum provides an interdisciplinary platform for grades K-12 teachers to engage students in wind energy science and technology.

History of the KidWind Challenge

Since it began in 2009, the KidWind Challenge Event has been successfully implemented in seventeen states. Over 7,300 students have competed in 55 Events across the country.

KidWind Challenge Goals

- Get students excited about the promise and opportunities of renewable energy—specifically wind power—and its relationship to global climate change.
- Foster opportunities for students to build, test, explore, and understand wind energy technology at a manageable scale.
- Get students—particularly girls and underrepresented populations—excited about careers in STEM fields related to renewable energy.
- Build capacity of teachers, coaches, and other educators to better understand wind energy technology and development, as well as its promise and limitations.
- Connect students to mentors and role models in the renewable energy industry.



2016 Challenge Structure

Event Competitions

KidWind Challenge Events take place during the school year and are hosted by schools, community centers and organizations from all across the country.

Online Competition

The KidWind Challenge Online is open 24/7/365, with cash prizes and new winners selected each month. All you need to compete is an internet connection anywhere in the world! Form a team, design a wind turbine, and upload your data. Every month, a winner will be announced and awarded $100.

Who can participate?

Any group of students in grades 4–12 are eligible to enter a team in any of the KidWind Challenges (Event or Online). This includes students from public and private schools, home schoolers, after school clubs, Boy Scout and Girl Scout troops, etc. As long as you have a coach you can attend!

There are no restrictions on the number of members in a team; however, big teams can be problematic as members may not have enough work to keep them occupied.

Each team must have an coach. The coach will be responsible for registering the team for the competition and managing the team's progress.

Neither KidWind, nor any local group will provide or be responsible for supervision of students. We require that there is one adult for every ten students that attend a Challenge.

Rules for Building Competition Turbines

There are two competition turbine divisions: 4-8 grade and 9-12 grade.

General Challenge Rules

- Each team that registers must have their own turbine. You will not be allowed to modify another team's turbine and use it for testing. You cannot have one turbine shared between teams and simply change blades or other parts for each team.
- Your team's turbine must be able to fit inside the wind tunnel and must be able to operate within its 48" × 48" internal dimensions. It is highly recommended that you design your turbine to fit with plenty of room within these dimensions. Sand bags or other weights will be available to hold the turbine in place in the tunnel.
- 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.

Turbine Design Rules

- Your turbine must use KidWind's generator (KW-GEN) as the sole power generator for your wind turbine. If the judges cannot verify that the generator is the correct one, your team may participate but will be unable to win prizes.
- Your turbine may have only one of these generators.
- Power must be generated solely by wind generated by the wind tunnel.
- Your turbine can either be vertical or horizontal axis.
- You may attach parts to the generator to increase how fast or hard it spins (e.g. gears, bearings, supports, etc.).

Over the last few years students have used **wheels from bicycles** as part of their turbines. We have allowed these as the blades mounted to them are not made of **metal** and these wheels are designed to spin at high RPM. In 2016 we will still allow the use of these wheels, but please be aware that if the wheel assemblies appear unsafe local judges can **disqualify** these turbines.

- Your turbine may use a gearbox or pulley system to increase power output. You may use pre-manufactured gearboxes and other parts, but keep in mind that innovation is a critcal judging criteria, and parts that you make on your own will earn you more points.
- You cannot use pre-manufactured wind turbine blades or airfoils/sheets.
- Your wind turbine must be free standing. A tower/stand will not be provided.
- Metal, plexiglass, and other dangerous blade materials are highly discouraged. On occasion, we have allowed these types of blades to be used, but only after local judges determined that there was an extremely low risk of failure due to assembly. Send us photos if you are unsure. Please be aware that turbines will be disqualified if they are deemed unsafe by the local judges.
- 3D printed parts and components are allowed. While you do not have to use files you created, 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.
- You must have two wires at the base of your turbine. You must label which wire is positive and negative.

Who has to show up?

To be eligible for the competition, all members of your team must be present on the competition day. We require one adult for every ten students that attend a Challenge.

Exceptions include:

- Some of your team members are unable to attend because of a scheduling conflict with a school sanctioned trip (a signed note from the advisor is required).
- A team member cannot attend due to illness or family crisis (a signed note from the advisor is required).

Instant Challenges

At some KidWind Challenge Events, students may be asked to put their knowledge of wind energy to work at an Instant Challenge. Instant Challenges don't require any preparation or planning before the Challenge, just a solid knowledge

base to refer back to for on-the-spot engineering. These may include building a windmill to lift weights using a pile of common household materials, or designing sails to most efficiently catch the wind.

Results from these Instant Challenges do not dectract from a team's score, they only add points to push teams up in rank. The number of points that these Instant Challenges are worth will vary between Challenges.

Turbine Testing Procedure

Once the testing session begins you will be given two minutes to set up your wind turbine inside the tunnel.

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.

In order to receive full marks for functionality, your wind turbine must be able to start producing power once the wind tunnel is activated without external assistance.

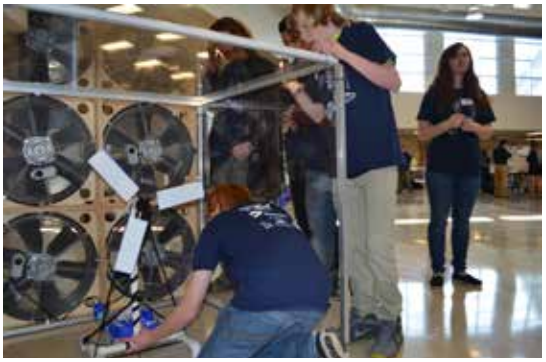
During testing the wind tunnel will be running constantly. We will collect power output data for 60 seconds. Your energy output score will be calculated using a Vernier data-logging system that collects voltage and amperage readings simultaneously.

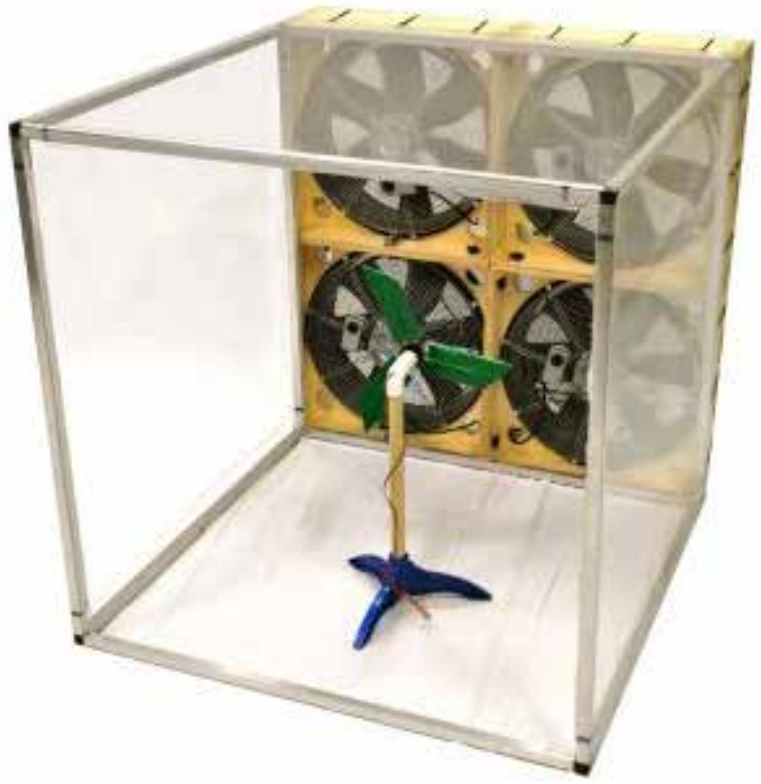
If your wind turbine slips, breaks apart, or falls over before the 60 second timer is started, you will either be given two minutes to set up your wind turbine again, or you will be allowed to remove the turbine to make repairs. In the latter case, you will be moved to the back of the line for retesting.

You will only be given one restart opportunity. It may be granted before the 60 second test begins, or once it has begun, but not both! Local judges have final say on rulings and protests.

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 lead to the most performance gains?





The newest wind tunnel model in use at the KidWind Challenge. Wind tunnel models will vary across different Challenge Events.

Wind Tunnel

Wind turbines will be tested in a 48" × 48" wind tunnel at a wind speed of approximately 3.5 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 deflection and torque on your gearboxes.

Prior to performance testing, student teams will be given time to test their devices in the wind tunnel. This will give you a chance to evaluate the conditions of the space.

Unlike a typical box fan, the newest model of the tunnel sucks wind through it instead of pushing. This creates a more powerful and consistent airflow to streamline testing. This will not affect the design requirements for your turbine.

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.

Register for a KidWind Challenge

Teams must register to attend a KidWind Challenge Event. There will be a $25 fee to register up to 10 teams, unless otherwise noted on the event registration page. Cut off dates vary so check the website for the latest information!

Materials for the KidWind Challenge

Whether you're registering a team for a KidWind Challenge Event or looking to host your own, we can provide you with as much equipment as you see fit. KidWind offers a number of materials to help you get started on your turbine project.

KidWind Generator (KW-GEN)

There is only one piece required for the KidWind Challenge: the KidWind Wind Turbine Generator (KW-GEN). This piece of equipment only costs $5, and they can be reused! Ask your teacher or school if they already have some.

KidWind Competition Wind Tunnel (KW-TUN)

This easy-to-construct device can be purchased from our partners at Vernier for $2000 + shipping.

Exploring Homemade Generators

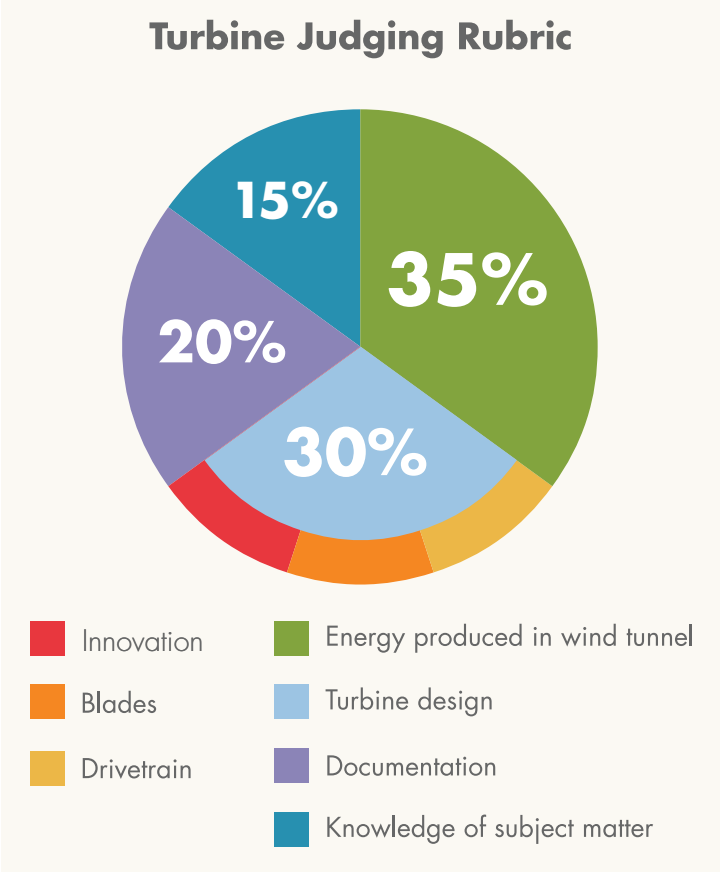
If you'd like to build your own generators, check out these kits to get started:

- GENPack (KW-GP). This add-on for the Advanced Wind Experiment Kit helps you explore homemade generators and AC current.
- simpleGEN (KW-SGEN). Make your own generator using this kit. Do some research or check out the KidWind Challenge page for ideas.

Data Logging Equipment

- Digital Multimeter (K-METR). Using a basic multimeter you can collect all the data you need to see how well your turbine is performing. Check out our online performance calculators.
- Vernier Energy Sensor (VES-BTA). KidWind uses Vernier equipment to test turbine performance. We use Vernier's simple device to easily measure power output.

You can find out more about purchasing this equipment and more at www.vernier.com. Turbine Judging Rubric



Turbine Judging Rubric

At some smaller or time constrained KidWind Challenge Events, teams may only be evaluated on energy produced and turbine design as there may not be enough time or staff to evaluate all of these categories.

Energy Produced (35% of score)

The total energy output of your turbine over the 60 second trial period will be collected using data logging software. Each team's energy output will be ranked relative to other competitors. Each team will receive points corresponding to their rank.

The turbine with the highest energy output (milliwatt-seconds or joules) over the 60 second trial period will score 40 points. The next 10 turbines will lose 2 points off the turbine ahead of them–so 11th place will score 20 points. Each subsequent turbine will lose 1 point off the turbine in front of it (i.e. 12th place will score 19 points, 16th place will score 15 points, etc.).

Turbine Design (30%)

A panel of judges will examine your wind turbine design before testing it in the wind tunnel. You must be prepared to discuss/defend the choices you incorporated into the design. The design criteria you will be judged on include:

- The choices and mechanisms by which you maximized power output
- Craftsmanship of your design, creativity, and economic and environmental decisions (eg. did you use recyclable materials? Can you take your turbine apart after the competition and reuse the parts?)

The judges will be very interested in how you developed and constructed specific parts of your turbine. Make sure you understand the decisions you made when constructing the following components:

- 10% Blades
- 10% Drivetrain
- 10% Innovation

Written Documentation of Design (20%)

Students must produce some type of documentation that reflects their design process and their 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 notebook
- Video (four minutes maximum)
- PowerPoint
- Science fair poster board

Students must provide the means to play a video or DVD, or run a slide show/PowerPoint, etc. We will not provide a computer or other device. Please keep videos to four minutes!

Knowledge of Wind Energy Subject Matter (15%)

Depending on the time allocated for the Challenge session, and the size of the Challenge, this component of judging may not be included. At many KidWind Challenges you may be asked about your general knowledge of wind energy issues.

The following are some important questions about wind energy. You can research them on your own, or browse the KidWind website for more information.

10 Big Questions

1. Devices that capture the energy in the wind come in many different forms: sailboats, kites, pinwheels, and so on. There are windmills to pump water and grind grain, there are wind turbines for your home and for the electrical grid, and there are vertical and horizontal axis machines. What defines each of these kinds of turbines? What are some important ways that they are similar and different? What makes your wind turbine similar to these devices? What makes your wind turbine different?
2. Climate change is major challenge facing the world. What are the environmental benefits of generating electricity using the wind? What are some of the tradeoffs? Why would we want to harness the power of the wind? What challenges might we face in generating 20–30% of US electricity from wind?
3. From what sources do we generate most of our electricity in the US? What are the primary sources of electricity used in your region of the US? How much does it cost to power your house each month? How much of the electricity that is used in the US is generated by wind? How has this changed over the last ten years?
4. In some local communities wind power can be controversial. Below are concerns voiced by local communities. Evaluate the validity of these claims by doing your own research.
    - Sound. People who live near wind turbines sometimes complain that the sound from the wind turbines is causing health impacts from vibration and other acoustical affects. There is data that supports both sides of this argument. What do you think?
    - Aesthetics. Wind turbines can be an eyesore to some people. What can be done with wind turbines to minimize this problem?
    - Environmental Impact (Habitat). Wind turbines can change local habitats and have caused significant bird and bat kills in the past. What is the impact on wildlife from wind turbines toda? How are biologists and ecologists dealing with these impacts?
5. As wind and solar power are relatively new energy sources to the US, they receive financial support to make them more economical. Fossil fuels and nuclear power receive subsidies as well. Do you feel that subsidies are appropriate in the energy industry? If you feel that they are okay, what energy sources would you subsidize and why?
6. A great deal of research is going into making wind turbines more efficient. What components of wind turbines are undergoing rapid change and development? Which changes seem to be having the most impact in improving turbine performance?
7. What causes wind? What are the windiest parts of the US? Where are most of the wind turbines located in the US? Are there any offshore wind farms?
8. What is the equation that defines how much power is in the wind? What are the most important variables? How does this equation affect turbine design and placement?

9. Developing and installing renewable energy, like wind and solar, requires professionals and experts from many different fields of study. What are some of the careers and jobs that make renewable energy possible?
10. Wind turbines can only generate power when the wind is blowing, just like solar panels only generate power when the sun is shining. As we all know, the wind does not always blow and the sun does not always shine. How can we deal with this "variability" of renewable energy resources? How can we ensure that we have power whenever we need it without relying on fossil fuels?

Judging Interview Checklist

SCHOOL _____

TEAM NAME _____

MEMBERS _____

KidWind Generator Division: 4–8 and 9–12

The turbine must use the generator provided by KidWind (KW-GEN) as the sole power generator. The judges must be able to verify that the official Challenge generator is being used. If the judges cannot verify that the generator is the official Challenge generator, the team may participate, but will be unable to win any prizes.

- ☐ Turbine only uses one official KidWind Challenge generator.
- ☐ Power is generated solely by wind created by the wind tunnel.
- ☐ Turbine is either vertical or horizontal axis.
- ☐ Wind turbine is free standing (cannot be attached to tunnel).
- ☐ No gearboxes, airfoils, or blades that are premanufactured.
- ☐ Wires at the bottom of the turbine are labeled negative and positive.
- ☐ The rotor diameter of the turbine is less than 48 inches and fits inside the wind tunnel.

Judging Notes

Judges may take notes on the following criteria.

Did you feel that the team worked collaboratively together?

Did the team look as if they put a lot of effort into the construction of the turbine?

Did you get the impression that the team did a great deal of experimenting and testing to get the final result?

Were there any specific components of the turbine that stood out?

Any ideas on where they could have found improvement or made their turbine better?

General comments:

Judging Score Sheet

The judging sheet may be amended and/or modified up to the day of the competition.

TEAM NAME_____

SCHOOL _____

Grade Level

☐ MS ☐ HS

JUDGE SCORE:

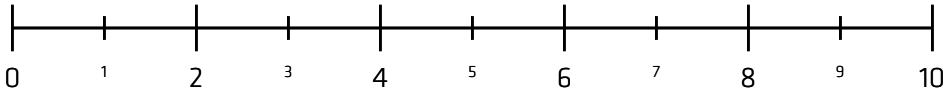
Power Output (35%)

mWs	Rank	Power Score

Turbine design (30%)

Blades (10%)

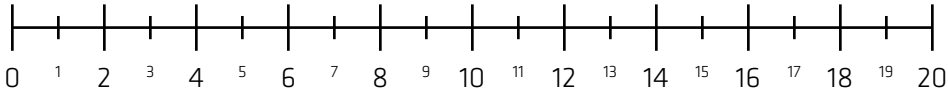
Drivetrain (10%)



Innovation (10%)

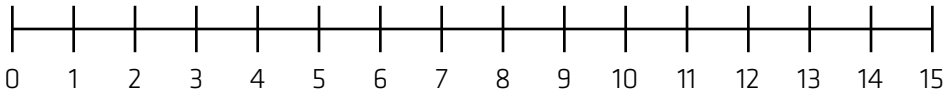
Total Turbine Design Score ☐

Documentation & Report (20%)



Total Documentation Score ☐

Demonstrated Knowledge (15%) *



* Please note this is an optional category and may not be used at all Challenges.

Total Demonstrated Knowledge Score ☐

Instant Challenge Score (BONUS) *

* Please note this is an optional category and may not be used at all Challenges.

Instant Challenge Score ☐

Add category scores to get team score:

Total Team Score ☐

Acceptable and Unacceptable Components

As stated, local judges have final call for safety. If you're not sure about something, send a photo to info@kidwind.org

✔ ACCEPTABLE

BICYCLE WHEEL

METAL BLADES WELL SECURED TO THE HUB

BLADES

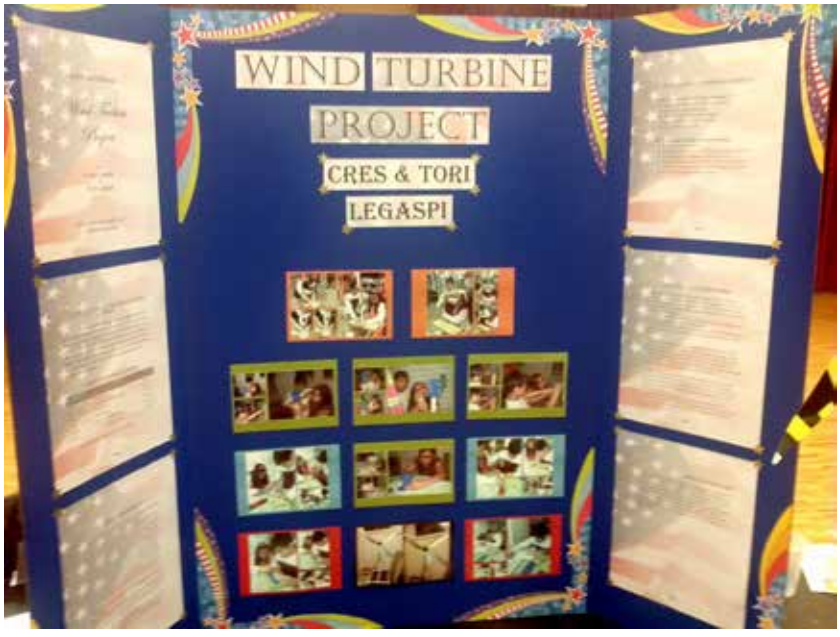
SHROUD

HOMEMADE GEARBOXES

✗ UNACCEPTABLE

PREMADE AIRFOIL-SHAPED BLADES

Examples of Competition Turbines



These metal blades are okay; they are well secured to the hub.

Generic KidWind Challenge Schedule

8:00am–10:00am Arrive at KidWind Challenge

Typically your team will arrive at a KidWind Challenge and be given a table or space to set up your turbine and other materials. As your team checks in we will usually distribute any materials for your teams. At most challenges we will have the wind tunnel out for students to make some final tweaks and a tool area so that you can make any last minute repairs.

10:00am Announcements & Introductions

At this time we will convene the teams, introduce the judges ,and give you some idea as to how the day will progress.

10:00am–2:00pm Turbine & 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.

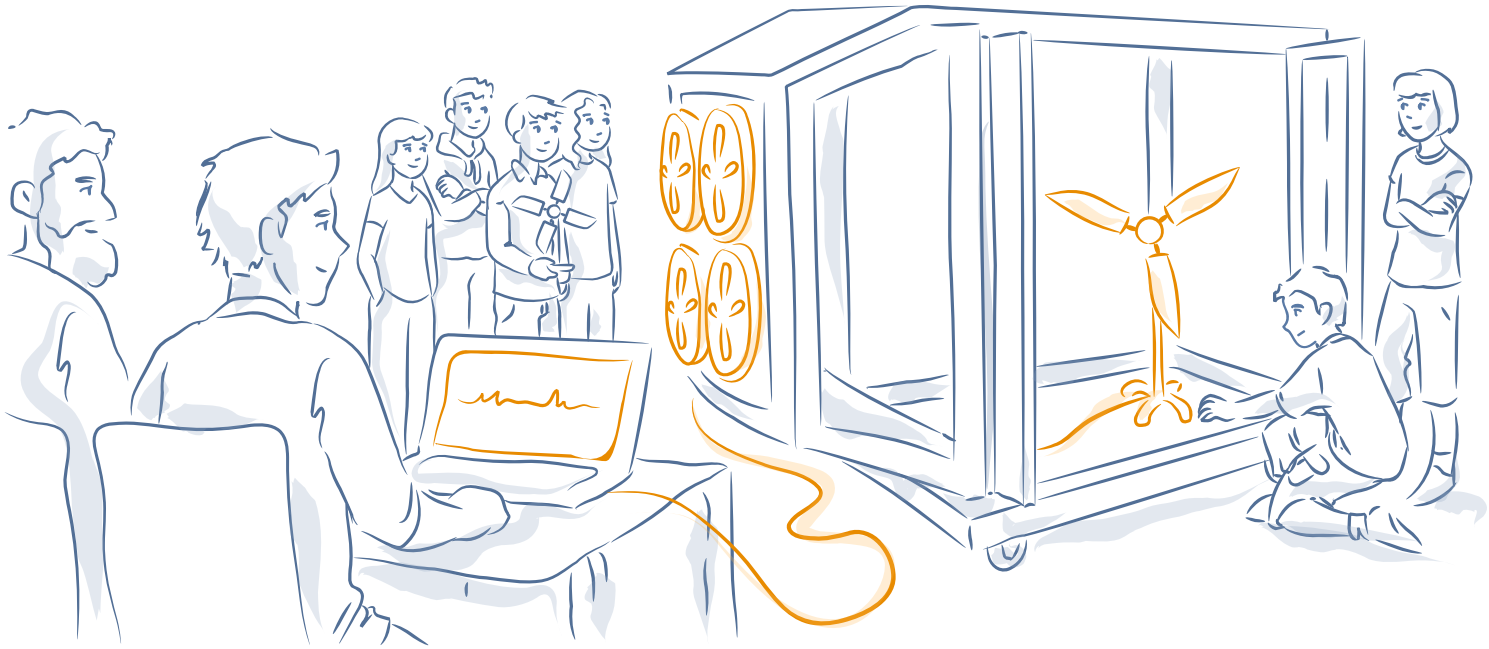
2:00pm Evaluation Events Completed & Judges Tabulate Scores

2:30pm Results & Prizes Announced

3:00pm End of Challenge

Food. Typically we do not provide food at events, although this depends on the budget we have for the event. Sometimes the Challenge is located in areas where food can be purchased and other times you may want to make sure that students have brought their own lunches.

Supervision. We ask that advisors bring their teams to the competition and that there is one adult supervisor for every ten participants.



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