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** REcharge Instructor/Teacher Buffalo
- **Cheryl Moeller** Executive Director, High Tech Kids
- **Charles Newcomb** Director Technical Strategy, Endurance Wind Power
- **Joseph Rand** Former Director KidWind Outreach & Training
- **Darlene Snow** Former 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 our Sponsors & Partners page.

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TABLE OF CONTENTS

Welcome to the KidWind Challenge! ........................................... 4
Generic KidWind Challenge Structure ........................................ 5
Turbine Testing ......................................................................... 6
Judging Criteria ....................................................................... 7
Rules for Building Competition Turbines ................................. 7
Examples of Competition Turbines ......................................... 8
Turbine Judging Rubric ............................................................ 9
Judging Interview Checklist ...................................................... 12
Judging Score Sheet ............................................................... 14
Resources .............................................................................. 15
Welcome to the KidWind Challenge!

So you want to be a judge at a KidWind Challenge Event? Either that, or someone got to you! However you found yourself here, we thank you for taking the time to get the next generation ready for a renewable energy future. While we call it a KidWind Challenge, it is more appropriately described as a celebration. A celebration of wind power, and the young engineers who want harness its power for good!

Are you nervous? The only thing you need to know is this: all judges decisions are final, so hooray—you can do nothing wrong! This guide should help you and the organizers do the following:

1. Know what is expected of you as a judge
2. Understand the performance characteristics of a small wind turbine
3. Be able to converse about wind energy issues in general

While we can’t make you an expert in this short document, we will do our best to help you find resources to get smarter if you are interested.

Since it began in 2009, the KidWind Challenge Event has been successfully implemented in seventeen states. Over 8,634 students have competed in 74 Events across the country.

The KidWind Challenge is much more than just building and testing wind turbines. Our stated goals are to:

- 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 the capacity of teachers, coaches, and other educators to better understand wind energy technology and development—and its promise and limitations.
- Connect students to mentors and role models in the renewable energy industry.

We thank you for your time. Without your efforts, these activities would not be possible.

Onward.

Michael Arquin, Director & Founder
Generic KidWind Challenge Schedule

8:00am–10:00am Arrive at KidWind Challenge
Typically teams will arrive at a KidWind Challenge and be given a table or space to set up their turbine and other materials. We will usually distribute materials as teams check in. At most challenges we will have the wind tunnel out for students to do some last minute testing, and we will have a tool area for them to make some final tweaks and repairs.

10:00am Announcements & Introductions
At this time we will convene the teams, introduce the judges, and give a overview of how the Challenge 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 students.
Turbine Testing Procedure

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

The wires at the base of the 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, wind turbines 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. Their energy output score will be calculated using a Vernier data-logging system that collects voltage and amperage readings simultaneously.

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

Teams only get one retest. It may be granted before the test begins, or once it has begun, not both!

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. Watch for blade deflection and torque on teams’ gearboxes.

Prior to performance testing, student teams will be given time to test their devices in the wind tunnel. This will give them 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 turbines.

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.

Remember, you have final say on rulings and protests.
Innovation

KidWind has a number of kits and parts that students can use to build and test wind turbines. While it is acceptable for students to use these parts at a KidWind Challenge, we want to foster innovation. We are looking for teams that make their own blades, gearboxes, and airfoils, as well as teams that try different ideas, such as vertical axis, multiple rotors etc. While an innovative turbine may not perform perfectly, points are given for innovation and creativity.

Rules for Building Competition Turbines

These are the full rules that the students are given. 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. They will not be allowed to modify another team's turbine and use it for testing. They cannot have one turbine shared between teams and simply change blades or other parts for each team.
- A 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 they design their turbines to fit with plenty of room within these dimensions.
- There are no budgetary restrictions for turbine design, but it is important to keep in mind that part of the judging process is the economical use of resources. Please check that all materials are used responsibly.

Turbine Design Rules

- Turbines must use KidWind's generator (KW-GEN) as the sole power generator for the wind turbine, or a homemade generator that is completely made by them. You must be able to verify that the correct generator is being used on their turbine. If you cannot verify that the generator is the correct one, the team may participate but will be unable to win prizes.
- Turbines may have only one of these generators.
Examples of Competition Turbines

These metal blades are okay; they are well secured to the hub.
• Power must be generated solely by wind from the wind tunnel.
• Turbines can either be vertical or horizontal axis.
• Teams may attach whatever they want to the generator to increase how fast or hard it spins (e.g. gears, bearings, supports, etc.).
• Turbines may use a gearbox or pulley system to increase power output. They may use pre-manufactured gearboxes and other parts. Innovation is a critical judging criteria, so keep this in mind if they use pre-made parts.
• Teams cannot use pre-manufactured wind turbine blades or airfoils/sheets.
• All wind turbines 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. Heavy blade material must be fastened with more than just glue! You make the final call here. If you think it is unsafe, do not run the turbine. Teams are aware that they can be disqualified for this.
• 3D printed parts and components are allowed as long as they have been designed by the team. You should ask for all CAD files if you have questions.
• Teams must have two wires at the base of their turbine. They must label which is positive and which is negative.

Who has to show up?
To be eligible for the competition, all members of the team must be present on the competition day. We require one adult for every ten students that attend a Challenge. Exceptions include:
• Some of their 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 a family crisis (a signed note from the advisor is required).

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.

Energy scores will be ranked on a comparative basis. The highest producing turbine will receive the full number of available points, and following turbines will follow in rank. The total number of points available will vary by Challenge.

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 (e.g. did you use recyclable materials? Can you take your turbine
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.

1. **How can wind power impact climate change?**
   Climate change is a 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?

2. **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? Why would you want to put a wind farm offshore?

3. **What kinds of devices transform the power of the wind?**
   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?

4. **How can we calculate the power in the wind?**
   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?

5. **How do we deal with wind variability?**
   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 the “variability” of renewable energy resources? How can we ensure that we have power whenever we need it without relying on fossil fuels? How could the science of meteorology impact these questions?

6. Where does our electricity come from? 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? Has this changed over the last ten years?

7. What are some of the negative impacts of wind power? In some local communities wind power can be controversial. Below are concerns voiced by local communities. If you were a wind farm developer, how would you address community concerns for the following impacts below?

   • 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 effects.
   • Aesthetics. Wind turbines can be an eyesore to some people.
   • Environmental Impact (Habitat). Wind turbines can change local habitats and have caused significant bird and bat kills in the past.

8. How do we pay for wind power? 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?

9. What does the future of wind energy look like? A great deal of research is going into making wind turbines more efficient. What components of

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**Questions judges may ask about student turbines**

- 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?
- What changes did you make to your turbine that lead to the most performance gains?
wind turbines are undergoing rapid change and development? Which changes seem to be having the most impact in improving turbine performance?

10. What careers are there in the wind energy industry? 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? What do you need to study to work in these fields?

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 detract from a team's score, they only add points to push teams up in rank. The number of points that these are worth will vary between Challenges.

Homemade Generators

Starting in 2016, homemade generators will be allowed to compete during the KidWind Challenge. Unlike in 2014, there will not be a separate division for homemade generators. The main requirements are as follows (students may be disqualified if they do not meet these criteria):

- The generator must be deemed safe by you. Output ranges of no more than 20V and 0.75 Amps are considered safe.
- The generator must be completely homemade by the students. They may use a kit or start from scratch.
- Most homemade generators use AC current power. To qualify for the Energy Output judging criteria, power must be in DC current. Students must buy or build a circuit that rectifies their AC current into DC.

You should inspect their device to make sure it is not doing any other power modifications to the output power. As a backup, we recommend that students ensure that their turbine can also use the regulation KidWind Generator.

Awarding Prizes at the Challenge

We think it is important to acknowledge student achievement during the KidWind Challenge. While we do award prizes and announce winners, the main goal of the KidWind Challenge is to explore the complexities of generating power from the wind and celebrate student design and a future powered by renewables. At many Challenges, sponsors fund prizes to incentivize teams to perform at the highest level.

At different Events, there may be a variety of prizes offered for student work. Below are some prize categories we recommend. There may be others depending on the Event.

- Overall (1st, 2nd, and 3rd for each division): Based on the raw score tabulated from the judging categories.
- Judges' Award: Acknowledge a team who may not have placed but impressed the judges with their spirit, determination, energy, or work ethic. Multiple of these awards may be awarded.
- Blades Award: Recognizes a team who may not have placed but who has constructed outstanding blades, and who their design's function. Generally only one of these are awarded per division.
- Student Choice Award: Students select the winners! Give voting sheets to all the teams and let them select the most creative, best constructed, etc.
- Generator Award: Recognizes a team who may not have placed but who have built the most creative and functional generator. This award levels the playing field for teams with homemade generators.
- Teamwork Award: Acknowledges teams who demonstrate excellent teamwork and cooperation.
- Other: In many Challenges, prizes are awarded for each of the judging criteria.
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 or a homemade 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).

☐ 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.
Notes
Please use this area to take notes about the team.

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:
# KidWind Challenge Judging Guide

## JUDGE SCORE:

### Power Output (35%)

<table>
<thead>
<tr>
<th>mWs</th>
<th>Rank</th>
<th>Power Score</th>
</tr>
</thead>
</table>

### Turbine design (30%)

#### Blades (10%)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

#### Drivetrain (10%)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

#### Innovation (10%)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Total Turbine Design Score**

### Documentation & Report (20%)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |

**Total Documentation Score**

### Demonstrated Knowledge (15%) *

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

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

**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**
Resources
Want to be a judge who knows lots about wind energy? Here are some resources to get your ready for the season!

Websites
- http://learn.kidwind.org/learn
- http://www.nrel.gov/wind/
- http://www.windpoweringamerica.gov/
- http://www.20percentwind.org/
- http://www.windenergyfoundation.org/about-wind-energy
- http://www.homepower.com/articles/wind-electricity-right-you

Books
- "Wind Power for Dummies" by Ian Woofenden
- "Wind Energy Basics" by Paul Gipe
- "Wind Power" by Paul Gipe
- "Homebrew Wind Power" by Dan Bartmann and Dan Fink
- "The Boy Who Harnessed the Wind" by William Kamkwamba