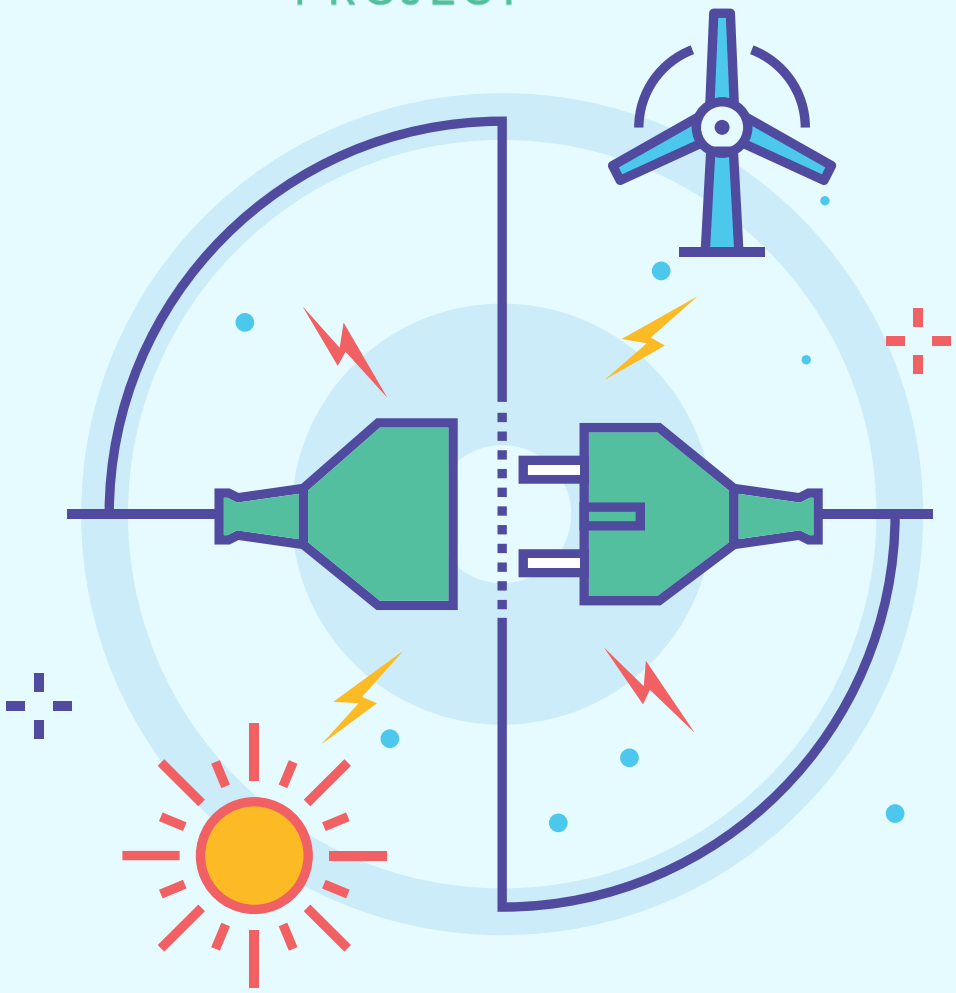
KidWind®
PROJECT



2022-2023 KidWind Challenge

WIND EDITION

RULEBOOK

www.KidWindChallenge.org
2093 Sargent Ave, Saint Paul, MN 55105 | Phone: 877.917.0079

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A Note on Reproduction

Dedication

Without some important visionaries, the KidWind Challenge would never have become the success that it is today. These organizations and individuals went out on a limb and helped us start something great. We thank them for their passion, energy, and continued support.

- Asia Ward, Co-Founder of Recharge Labs
- Joe Rand, formerly KidWind's #2
- Larry Flowers (formerly of NREL Wind Technology Center)
- Trudy Forsyth (formerly of NREL Wind Technology Center)
- Original KidWind Challenge Team: Brad Weaver, Andy Lueth & Linda Elie
- **New York State Energy Research Development Authority (NYSERDA)**
- Wright Center for Science Education at Tufts University
- **Vernier Science Education**
- **Harbec Plastics**

Partners & Volunteers

We have an amazing national outreach team comprised of individuals, organizations, and institutions who practically work for free. They love this project and make the magic happen at our local and regional events. Without their hard work and dedication, none of this happens. I would like specifically call out some superstars!

Individuals

- Andy Lueth
- Angela Christine Stoltz
- Casey Heiser
- Colleen Fisk
- Colleen McDaniel
- Curtis Morgan
- David Andrade
- David Carter
- David Yaffe
- Diane Painter
- Elise DeGeorge
- Fran Poodry
- Gus Goodwin
- Ian Baring Gould
- James Brown
- Jerry Bernardini
- Kathy Jackson
- Kerri MacKay
- Meghan Phadke
- Michael Phalen
- Mike McNally
- Mike Rinaldi
- Parker Mullins
- Peter Zack
- Ray Alls
- Ray Pitcher
- Remy Pangle
- Richard Anderson
- Romie Tejeda Barron
- Yvonne Cook
- Tim Noonen

Organizations and Institutions

- CEEWA
- CREATE Program
- Cradle of Aviation
- Department of Energy - Collegiate Wind Competition and affiliated colleges
- Department of Energy - Wind for Schools Program and affiliated state programs/ universities
- Flinn Scientific & WhiteBox Learning
- Kansas Energy Program
- KEH Marketing
- National Society of Black Engineers
- Renewable Energy Alaska Project
- REpowering Schools
- SpirtWind Kidz Ranch
- Women of Renewable Industries and Sustainable Energy (WRISE)

Educators, Students and Parents

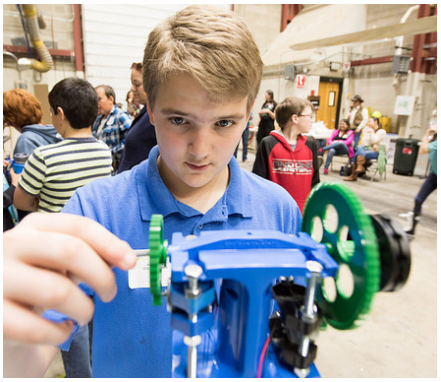
None of this happens without all of the great educators and students willing to try something new and the parents that support them! Thanks for all your passion and vision!

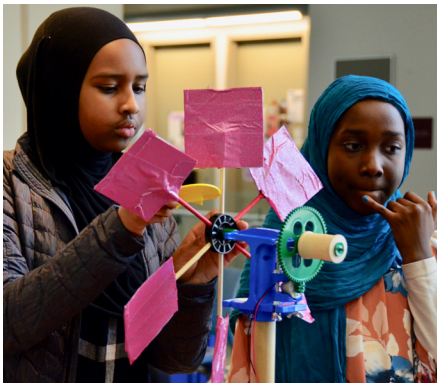
Sponsors

While KidWind self-supports a few Challenge events around the country, our impact would be greatly limited without grants and sponsorships from renewable energy industry organizations and foundations.

Sponsoring a KidWind Challenge demonstrates an investment in our clean energy future. We invite you to share in our passion to inspire these futures energy leaders, engineers, scientists, innovators, and problemsolvers.

Please contact **michael@kidwind.org** to become a sponsor.





Thanks to our 2021-2022 Sponsors!

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Breezy Backers ($5,000+)

Apex Clean Energy

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Kansas Electric Cooperatives, Inc

Madison Gas and Electric

Tiger Solar

Urban Solar Grid

VAREA

What is the **KidWind Challenge?**

The *KidWind* Challenge is a hands-on design competition that engages students in STEM through the lens of wind and solar energy. Student teams design and construct small wind turbines and solar devices that they test, and then meet with a panel of judges to present their design process and demonstrate their conceptual knowledge on renewable energy. Teams also engage in a variety of Instant Challenges to gauge their on-the-spot teamwork and problem-solving skills.

The KidWind Challenge is a team effort by teachers, students, engineers, and practitioners, all working to make wind energy education and other renewable energy education accessible in classrooms around the world.

Since 2009, KidWind Challenge events have been successfully implemented in 37 states, with roughly 35,000 students competing in 240 events across the country to date.

KidWind Challenge Goals

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

How to **Participate?**

You can participate and prepare for KidWind Challenges in many ways. We recommend starting by exploring the website and trying an online wind or solar challenge. This will help you get a feel for the kind of devices you have to build and the kind of data you need to provide at a KidWind Challenge Event. Once you are ready you can take your devices on the road and participate in one of our KidWind Challenge events. Those top performers from the online and local events are invited to participate in the annual National KidWind Challenge.

Event Challenges

KidWind Challenge Events take place during the school year and are hosted by schools, community centers and organizations across the country. Please note that not every site will have both a wind and a solar challenge. KidWind Challenge Events may occur inperson, online, or in a hybrid model. To find details about your local event, check out the Events page for your particular event and/or contact the local organizer.
Learn more here.

National Online Challenge

The online challenge allows students to construct and test wind turbines and/or solar devices, and share the results with the KidWind community. Anyone, anywhere, can participate online. Every month we deliberate on the best projects and send prizes, t-shirts or other swag to the student winners. Monthly wind winners are also invited to the National KidWind Challenge.

There are no age or materials restrictions. Just share what you have created with our team and we will pick some of our favorites each month.
Learn more here.

National Simulation Challenge

Last year, 90 teams participated in the first ever National Simulation Challenge developed in partnership with Flinn Scientific's WhiteBox Learning (WBL). The Simulation Challenge allowed students from all over the United States to explore wind turbine blade and wind farm design in a game-like environment. To be selected as a top performer, teams had to master several complex concepts and work through hundreds of iterations to discover the best blade designs and wind farm architecture.

The 2023 National Simulation Challenge begins on January 1, 2023.
Learn more here.

National Challenge

Each year, the top 2 to 3 teams from our local wind events and the monthly winners from our online wind challenges are invited to participate in the National KidWind Challenge. For now, the National Challenge is focused on the wind part of the KidWind Challenge, but we hope to expand this to include solar challenges in the near future.

The 2023 National KidWind Challenge will take place from May 22-25.

Who Can **Participate?**

Virtual Challenges

Any student, anywhere in the world can participate in our virtual challenges.

The General Online Challenge is open to all students in any grade or school setting. Many organizations and regions are also hosting online challenges, though these may have specific grade or geographic restrictions. While these Online Challenges are virtual, they do require you to build a physical structure.

Students who are unable to physically build a turbine, may participate in our Simulation Challenge which is hosted via the WhiteBox Learning online portal and open to all students in all grade levels.

Event Challenges

Any group of students in grades 4 to 12 is eligible to enter a team in a KidWind Challenge Event. 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 and a team, you can attend!

There are no restrictions on the number of members on a team; however, large teams can be problematic as members may not have enough work to keep them occupied. Some large teams divide the students into groups with one half doing a wind challenge and the other half doing a solar challenge.

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 at a Challenge. We require teams to make sure that there be one adult for every ten students who attend a Challenge.

Can I Hold a KidWind Challenge?

Many educators ask us if they can host a KidWind Challenge. For the most part we say go for it, but start slow!

Start out by holding a KidWind Challenge in your classroom: upload a list of the team members to our online challenge and compete virtually. If that goes well, try to visit a KidWind Challenge near you to see a preview.

Holding a KidWind Challenge Event that is open to a large region can be complicated, but if you want to give it a try, we can help you! If you have some kind of wind tunnel, understand the rules, and want to invite local schools and have an event, shoot us an email and let's go for it! To have a KidWind sanctioned event that will show up on our map you need to contact our team. We will help you make sure it is organized and well run. We often like to have one of our instructors come and help make sure the event meets KidWind standards.

We want to see KidWind Challenges and similar events all over the globe, which is why we open source all of our materials. But for us to put our name on an event we need to be confident the event has all the official components.

See our website for more info about holding your own KidWind Challenge.

What Does an **Event Look Like?**

The KidWind Challenge network of partners and volunteers is vast. We hold events all over the world in many different venues. We want these events to be driven by the energy and vision of our local partners. This means that while every KidWind Challenge is similar, they are not exactly the same.

Most events follow our general rules and rubrics, but there maybe some variations in schedules, events, judging, and instant challenges. Please contact your local organizer for details about your specific event.

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 bring their own lunches. Please check the KidWind Challenge website and connect with your local coordinator to see if lunch will be provided.

Supervision

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

Sample Schedule

- **8:00am–9:30am**
  Arrivals + Set-up
  Typically your team will arrive at a KidWind Challenge and be given a table or space to set up your turbine and/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. We will also have lamps set up for testing solar devices.
- **9:30am**
  Announcements & Introductions
  At this time, we will convene the teams, introduce the judges and give participants some idea as to how the day will progress.
- **9:30am–2:00pm**
  Turbine, Solar Device, 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.
- **2:00pm**
  Evaluation Events Completed and Judges Tabulate Scores
- **2:30pm**
  Results and Prizes Announced
- **3:00pm**
  End of Challenge

Wind **Challenge**

Introduction

The very first KidWind Challenge was held in a science classroom in Monterey, CA, in 2003. It was a spontaneous end of year project for Michael Arquin's 6th grade science class. He had been searching for a fun open-ended wind project similar to Junior Solar Sprint that he had been doing with his students for years, but could not find anything similar in the wind arena. He spent a little time developing the idea, collected some materials and off he went with his classes. Based on the student response, it was clear this project idea had legs. Even though it was the end of the year, students were showing up before school and at lunch to work on their turbines. It was a blast!

Years later in 2009, with support from NYSERDA, KidWind held the first four KidWind Challenges across New York State. These events were inspired by a wind energy challenge, WindEng, we discovered was being held at the University of Guelph in Canada. The University of Guelph had a real wind tunnel --- so we first needed to solve a big problem. If we were going to hold the challenge in various locations, we would need a portable wind tunnel. Experts told us it that would cost $50K to make a portable wind tunnel, so we took it to some different experts and gave a group of high school students $1000 to build a portable wind tunnel – which they did! We carted this monstrosity around the state to our four Challenges. It wasn't perfect but WOW it was fun. After those first four events, we were hooked. We have spent the last 10 years refining KidWind Challenges, and we are addicted to making them better, more interesting, and more challenging!

Every year the students get more imaginative and more inspiring. The devices that students construct continuously blow us away and keep pushing us to work harder and smarter to create authentic educational opportunities for students.

We can only imagine what the next ten years will hold!

Wind Resources

As you construct and test your wind turbine, you may want to learn (or learn more about) the major parts of a wind turbine, wind energy and other related topics.

Check out these sites to learn about wind turbines and wind energy in general:

- → **Student Energy - Wind Power**
- → **PBS Wind Power Episode**
- → **Department of Energy - Wind**
- → **National Renewable Energy Lab - Wind**
- → **Wind with Miller**

Participation **Checklist**

There are two ways you can participate in a KidWind Challenge: Online or at an KidWind Challenge Event.

KidWind Wind Challenge Online

- ☐ Explore student turbines on the Online Challenge
- ☐ Learn about the basic parts of wind turbine
- ☐ Get some turbine-building equipment
- ☐ Build a turbine
- ☐ Test and improve your turbine, over and over
- ☐ Collect some data about your turbine
- ☐ Upload information about your turbine and your team to the Online Challenge
- ☐ Wait to see if you are the monthly winner

KidWind Wind Challenge Event

- ☐ See if there is a KidWind Challenge Event nearby
- ☐ Find a coach and form a team
- ☐ Send your coach to a virtual or in-person workshop!
- ☐ Explore student turbines on the Online Challenge
- ☐ Learn about the basic parts of a wind turbine
- ☐ Get some turbine-building gear
- ☐ Build a turbine
- ☐ Test and improve your turbine, over and over
- ☐ Collect some data about your turbine to share with judges (notebook, video, etc)
- ☐ Fill out your Wind Project Profile Form
- ☐ Before you go to the Event Challenge try the Online Challenge
- ☐ Get to Event Challenge and have fun
- ☐ If you place in the top two, get an invite to the National KidWind Challenge

Don't forget to register your team for your local KidWind Challenge! Check the website for upcoming events in your area and links to registration.

KidWind Simulation Challenge

- ☐ Make sure you have an internet connected computer
- ☐ Register for the Simulation Challenge **here**
- ☐ Receive your WhiteBox learning log-in details.
- ☐ Get to work once it opens on January 1

What do I bring to the Challenge?

- → Turbine
- → Wind Project Profile Form
- → Extra parts, just in case
- → Tools, just in case
- → Pen/pencil
- → Snacks
- → Water bottle
- → Extra documentation for the judges (poster, notebook, photos)

Wind Challenge Divisions

There are three possible age divisions:

- Elementary Division (3rd-5th Grade)
- Middle School Division (6th-8th Grade)
- High School Division (9th-12th Grade)

Note: Specific events might have different age or grade divisions based on local grade banding. See the event details on the website for more information.

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

- **KidWind Generators**
- Home-built generators (AC or DC)
- Advanced Generators (AC or DC)

If you use a KidWind generator, you will be in the KIDWIND GEN DIVISION. If you use a homebuilt or advanced generator, you will be in the OPEN DIVISION. You must design your turbine so the judges can see your generator. Only teams participating within the same division will be competing against each other.

Who Has to Show Up?

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

Exceptions include:

- Some of your team members are unable to attend because of a scheduling conflict with a schoolsanctioned trip.
- A team member cannot attend due to illness or family crisis.

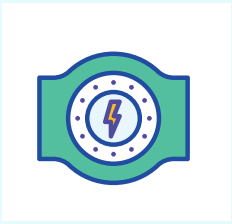
Can I Change Generator Divisions at an Event?

The short answer is it depends. Generally we want students to experiment and be ready to compete. We realize that sometimes things do not work as planned and you want to make a change. Teams should realize that if you change to a different generator division, you may get fewer tests and fewer chances to tweak and improve your device. Once the tunnel testing is closed, you will need to declare the division you would like to be placed. Events are very busy, and at this point in the event we will not have full scores tabulated, so you will need to make an educated guess as to which division you will want to compete.

For more details and clarification, please contact your local event organizer.

Equipment **to Build Your Turbine**

Whether you're building a turbine for an online or challenge event, you will need some basic gear to get started. KidWind, through our partners at Vernier, have a number of kits and materials to get you exploring, but you can use gears from anywhere to participate in a KidWind Challenge as long as you are not violating the rules.



Generators

The generator your team uses 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 GEN DIVISION)

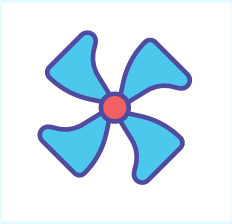
The easiest path is to get a few **KidWind Turbine Generators from Vernier.** If you use this generator, you will be in the KIDWIND GEN division.

Homebuilt Generators (OPEN DIVISION)

If you'd like to build your own generator, our partners at Vernier sell the **GENPack (KW-GP)** or the **simpleGEN (KW-SGEN)** which can be a good way to start learning about building your own generator and conditioning AC output to DC. You can also find many more resources and kits online about building your own generator. For the really studious, check out **Homebrew Wind Power** by Dan Bartmann and Dan Fink and construct your own generator and turbine from scratch!

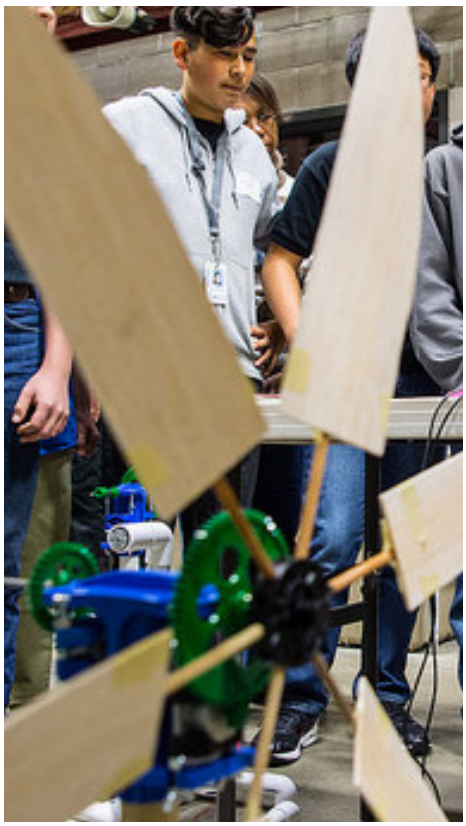
Advanced Generators (OPEN DIVISION)

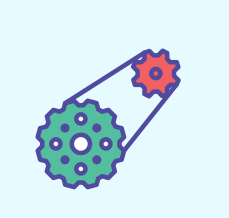
The key to using a homebuilt or advanced generator is to make sure the power output does not exceed 30V at 1A at any point in testing. You will also have to properly match a load to your generator for maximum efficiency. This can get complicated!



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 wood, 3D

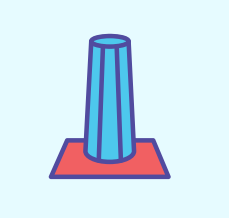




Gearboxes or Belt Drives

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 your can construct your own gearboxes or belt drives. The only rule is that we must approve it as safe!



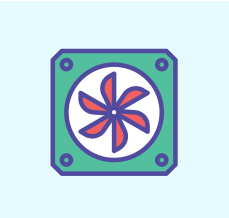
Towers

You can make a tower for your wind turbine out of practically anything. Check out these plans to make 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 will need to 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 our workshops and while we are preparing and tinkering, we like to use simple box fans. At KidWind Challenge events, we will have a **KidWind Competition Wind Tunnel (KW-TUN)** or something very similar to test your turbine. The KidWind Competition Wind Tunnel is easily constructed and can be purchased from our partners at Vernier.

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 which leads 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.

Through our partners at Vernier, you can get more sophisticated data collection equipment. We really love their **Go Direct Energy Sensor (GDX-NRG)**. It connects to all devices and is an easy way to collect detailed turbine data and even has a built in load.

Learn **More Online**

You can find more details about each part of a wind turbine at the KidWind Challenge **website**.

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. You have three options for choosing what this generator will be:
   - → You can use KidWind Wind Turbine Generator (KW-GEN)
   - → You can construct your own generator using a kit, online plans, or your own ingenuity.
   - → You can select a different AC or DC generator that better matches how much power your turbine can generate.
5. If you construct your own generator or use an advanced generator, you will be placed in the OPEN DIVISION for energy production at local and national challenges. If you use a KidWind Generator you will be placed in the KIDWIND GEN Division. Judges will inspect your generator to determine in which division your team will participate. Please make sure that your generator is visible.
6. Power must be generated solely by wind using the wind tunnel.
7. Your turbine can be built on either a vertical or horizontal axis.
8. Your turbine may use a gearbox, pulley system, or similar mechanism to increase power output. You may use premanufactured 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.

Connection and Loads

- → You must have two wires at the base of your turbine. You must label which wire is positive and negative, and the 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 tested 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 may 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.
- Local judges reserve the right to use other methods to collect power and energy output data if probeware

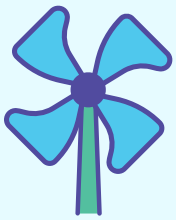
9. You cannot use pre-manufactured wind turbine blades or airfoils/sheets.
10. Your wind turbine must be free-standing. A tower/stand will not be provided.
11. Metal, plexiglass, and similar blade materials are highly discouraged because they are potentially dangerous. On occasion, we have allowed these 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.
12. 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.
13. 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.
14. While the use of shrouds to channel the wind is permitted, the turbine and the shroud must fit COMPLETELY inside the wind tunnel to qualify. If any part of the shroud is outside of the wind tunnel during the test, the turbine will be disqualified.

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

Turbine Design Rules

Wind Tunnel

- Wind turbines will be tested in a 48" x 48" wind tunnel at a wind speed of approximately 3.5 to 5m/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 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.

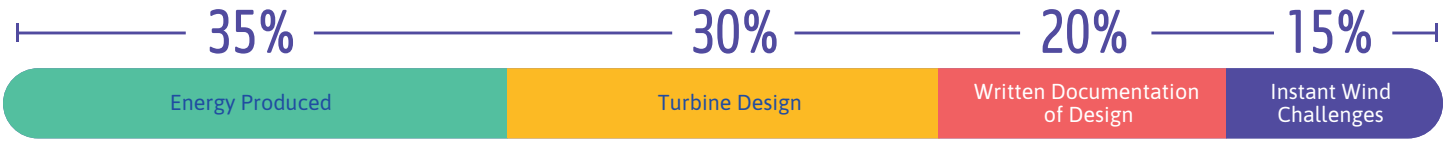


Turbine Testing

- 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 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 score will be calculated using a Vernier datalogging system that collects voltage and amperage readings simultaneously.
- If your wind turbine slips, breaks, or falls over once the 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.
- 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 we 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.
- Local judges have final say on rulings and disputes.

How Will Your **Turbine and Team Be Evaluated?**

At every KidWind Challenge, teams can expect to be evaluated on energy produced. Depending on the local event and the number of teams present, there may be turbine judging and instant challenges that also are part of your overall score.



Please keep in mind that Judging Rubrics and categories may be different at your local event. Your local organizer will share details of how your turbine will be evaluated prior to your event.

Energy Produced (35%)

The total energy output of your turbine over the 30 to 60 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.

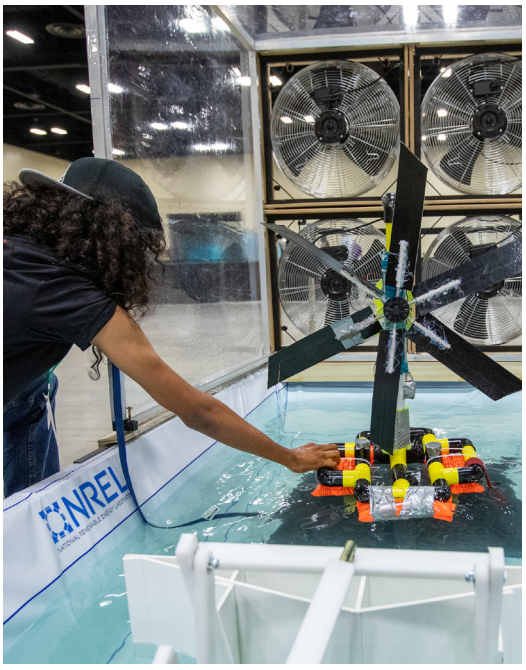
Rank Method

Turbines will all 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 to 5 point 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 (30%)

A panel of judges will examine your wind turbine design at a KidWind Challenge. This 15 to 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 lead to the most performance gains?
- Discuss the craftsmanship of your design, including creativity, economic, and environmental decisions.
- Did you use recyclable materials?
- Can you take your turbine

Written Documentation of Design (20%)

All students must complete a Project Profile Form (see Appendix). 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
- Videos (maximum of 4 minutes)
- PowerPoints
- Science fair poster boards

Students must provide the means to play any multimedia. We will not provide a computer, speaker, or other media devices.

Instant Wind Challenges (15%)

At some KidWind Challenges, 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 to for on-the-spot engineering.

These challenges may include building a windmill to lift weights using common household materials, or designing sails to most efficiently catch the wind.

The number of points that these Instant Challenges are worth will vary among Challenges.

During past Challenges, Instant Challenges have added 10 to 20 points to the final score. At some locations, we may be piloting bonus Instant Challenges and other categories for testing. Please check the KidWind Challenge website and your local Challenge registration page for more details.

Appendix

10 Big Questions **About Energy**

Here are some questions to get you thinking about renewable energy in broader terms. You will likely need to draw on your understanding of these questions to be successful at instant challenges, knowledge tests, and in the judging room!

You do not need to become an expert! Just make yourself knowledgeable.

1. How do we generate and use electricity — and how do we move it around?

From what sources do we generate most of our electricity in the U.S.? How does a generator work? What are the primary sources of electricity in your region of the U.S.? What are some of the ways we transform energy from one form to another? How much of the electricity that is used in your country is generated by wind, solar, or other renewable energy? How has this changed over the last ten years? How do we move electricity from power plants to our homes? What is distributed generation?

2. How do we measure and quantify electricity?

What are the units we use to measure electrical energy consumption? How much does it cost to power your house each month? What is the difference between energy and power? How much power and energy do common objects like toasters, TV, cell phones and other devices use? Can you read a power bill? How can we reduce our electrical consumption or make it more efficient? How does electrical energy usage vary between countries?

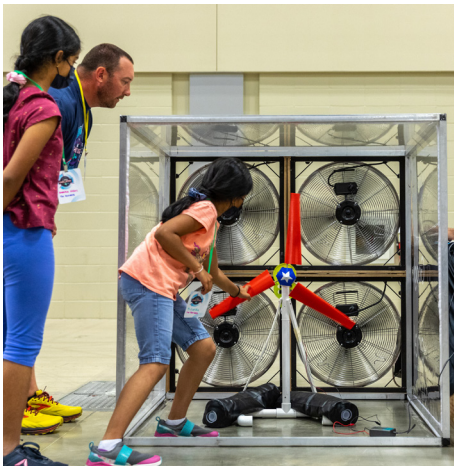
3. What is climate change and how can renewable energy impact this phenomenon?

What is climate change? What are the environmental benefits of generating electricity using wind or solar power? What are some of the tradeoffs? What challenges might we face in generating over 50% of electricity from renewable resources in the U.S.? How does efficiency and conservation play a role in reducing the climatic impact of electricity generation?

4. What kinds of devices transform the power of the wind and the sun?

What types of devices have been used to harness wind or solar power, apart from being used to generate electricity, and what were their uses? What are the various styles of windmills and turbines? What are the various types of solar thermal and solar photovoltaic panels. What is the equation that defines how much power is in the wind and what are the most important variables? How do we measure the power coming from the sun? What components of wind turbines are undergoing rapid change and development? Which changes seem to be having the most impact in improving turbine performance? How has the performance of solar panels been improved?

Wondering where to start exploring these questions? Check out the KidWind website for important links and resources: **KidWind.org**



5. How does weather and geography impact renewable energy production?

What causes wind? What are the windiest or sunniest parts of the U.S.? Where are most of the wind turbines or solar farms located in the U.S.? How does an offshore wind farm work, and where are they located? How do the seasons affect wind or solar energy production? How could the science of meteorology impact and improve the performance of solar or wind farms?

6. How can we store electricity?

What is electrical storage? How can storage impact the "variability" of renewable energy resources? What are the challenges of implementing small or large scale storage? What kinds of technologies are used in the storage of electricity? Electric vehicles have huge batteries in them — can we use them for storage in our homes?

7. What are local impacts of a wind and solar powered future?

What are some of the physical and social impacts of solar and wind farm construction and operation? How can we reduce these impacts? Which impacts seem most concerning to local communities? How do these impacts compare to those of fossil fuel generating facilities?

8. How do we pay for renewable energy?

How do we financially subsidize renewable energy resources? How does this compare to fossil fuel and nuclear subsidies? Do you feel that subsidies are appropriate in the energy industry? If you feel that subsidies are okay, what energy sources would you subsidize and why? How can we provide affordable, clean energy to all communities around the globe?

9. What does a renewable energy powered future look like?

Is it realistic to think we can power the grid with 100% renewable energy? What role does nuclear have to play in a clean energy future? What are smart grids and microgrids and how could they be an improvement over the power grid we currently have? How would large numbers of Electric Vehicles impact the power grid? How can use less electrical energy but still have all the modern conveniences we want?

10. What are renewable energy careers?

Developing and installing renewable energy components and systems like wind turbines and solar panels, 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?

**The development of these questions was guided by the DOE Energy Literacy and NGSS Energy Standards.*

Wind Project **Profile Form** (Novice)

Team Name: School Name:

This document is meant to help guide your design process and provide documentation to the judges about your wind turbine. You should present this document to the judges at your KidWind Challenge event.

1. ☐ **a. We are using a KidWind Generator**

☐ **b. We are using a premade, non-KidWind generator.**

Brand/Model/Where you got it:

☐ **c. We made our own generator.**

Describe the design/construction:

2. **Does your turbine fit in the 4'x4' wind tunnel?**

☐ **Yes** ☐ **No**

3. **Do you have wires at the bottom of the wind turbine?**

☐ **Yes** ☐ **No**

4. **Are your wires labeled + and - ?**

☐ **Yes** ☐ **No**

5. **Do you have a gearbox?**

☐ **Yes** ☐ **No**

a. If so, what is your gear ratio?

6. **What was your maximum voltage output?**

7. **If your turbine was under a load at the time of testing the voltage, describe the load.**

8. **How many blades**

9. **What materials are the blades made from?**

10. **What was the optimal pitch of your blades?**

Don't forget to bring the following items to the Challenge:

- **Your wind turbine**
- **This form!**
- **Any notebooks, drawings, videos that you kept while building your structure**
- **Wiring Drawing that details your circuit**

Wind Project **Profile Form** (Advanced)

Team Name: School Name:

This document is meant to help guide your design process and provide documentation to the judges about your wind turbine. You should present this document to the judges at your KidWind Challenge event.

1. ☐ **a. We are using a KidWind Generator**

☐ **b. We are using a premade, non-KidWind generator.**

Brand/Model/Where you got it:

☐ **c. We made our own generator.**

Describe the design/construction:

What resources did you use to guide your design (books, kits, etc.)?

2. What kind of power does your wind turbine generate

☐ **a. AC:** Did you rectify your output to DC?

☐ **Yes** ☐ **No**

☐ **b. DC:** Is your power output conditioned to be DC and below 30V and 1A?

☐ **Yes** ☐ **No**

3. Does your turbine fit in the 4'x4' wind tunnel?

☐ **Yes** ☐ **No**

4. Do you have wires at the bottom of the wind turbine?

☐ **Yes** ☐ **No**

5. Are your wires labeled + and -?

☐ **Yes** ☐ **No**

6. Do you have a gearbox?

☐ **Yes** ☐ **No**

a. If so, what is your gear ratio?

7. What was your maximum voltae output?

8. If your turbine was under a load at the time of testing the voltage, describe the load.

Don't forget to bring the following items to the Challenge:

- **Your wind turbine**
- **This form!**
- **Any notebooks, drawings, videos that you kept while building your structure**
- **Wiring Drawing that details your circuit**

Wind Project **Profile Form** (Advanced) Continued

9. **What materials did you use?**

10. **What was the optimal pitch of your blades?**

11. **Detail any use of airfoils in your design.**

☐ No airfoils used.

12. **Detail any computer software you used to design/print/build your blades.**

☐ No software used.

13. **Detail any advanced manufacturing used to create your wind turbine (i.e. laser cutting, 3D printing, etc.).**

☐ No advanced manufacturing used.

14. **Describe any mechanisms or capacitors you have used to store electricity.**

☐ No mechanisms or capacitors used.

15. **Detail any microcontrollers integrated into your device. Describe the goal and the benefit of your microcontroller(s).**

☐ No microcontrollers used.