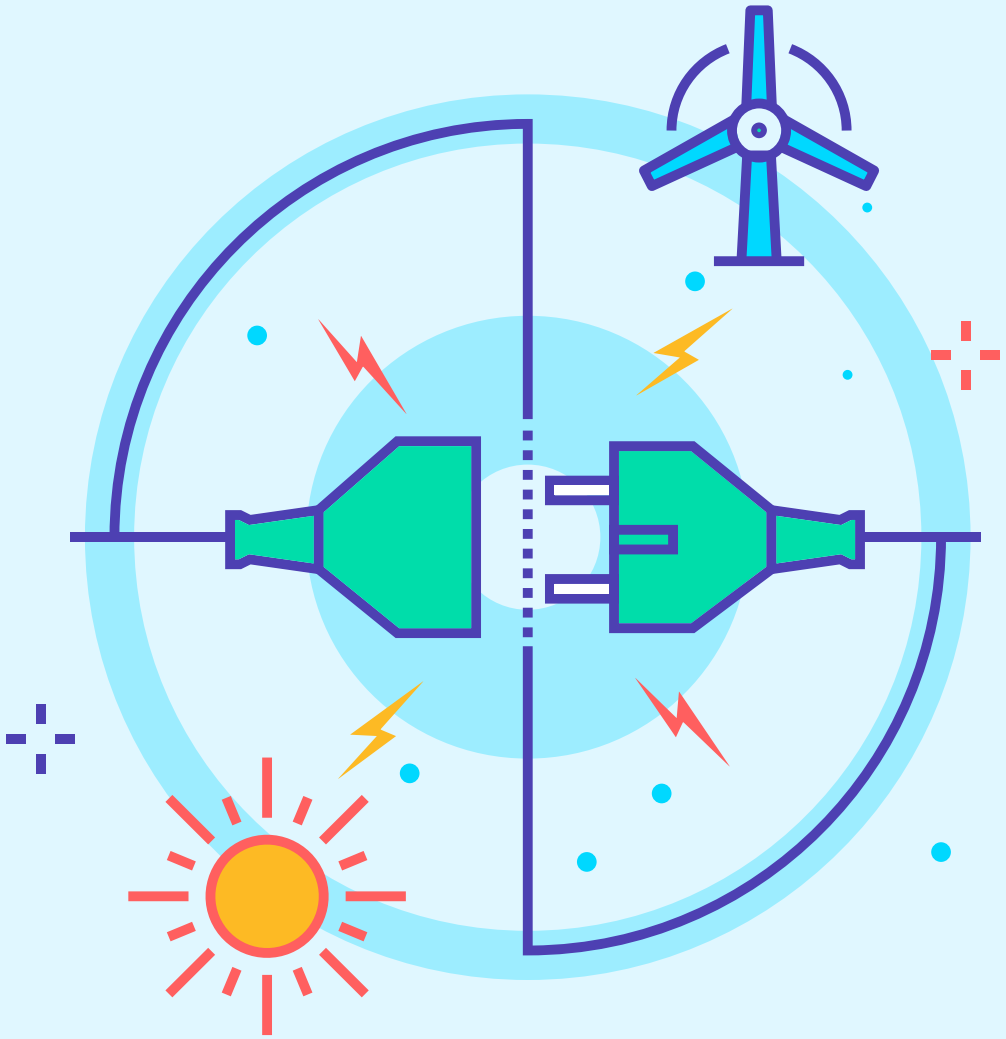
KidWind®
PROJECT



2019-2020 KidWind Challenge
RULEBOOK

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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**
- Dick Michaud (formerly of the Department of Energy, Boston Office)
- 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 Software & Technology**
- **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
- Arthur Morken
- Carl Joseph
- Colleen McDaniel
- Curtis Morgan
- Elise DeGeorge
- Fran Poodry
- Gus Goodwin
- Ian Baring Gould
- Jake Hopkins
- Jason Martin-Hiner
- Jon Roschke
- Jordan Menning
- Kathy Jackson
- Kurt Thonnings
- Leah Bug
- Lee Jay Fingerlish
- Meghan Phadke
- Michael Phalen
- Peter Zack
- Ray Alls
- Ray Pitcher
- Remy Pangle
- Richard Anderson
- Stefanie Brown
- Yvonne Cook
- Tim Noonen

Organizations and Institutions

- Cradle of Aviation
- Department of Energy - Collegiate Wind Competition
- Department of Energy - Wind for Schools Program and Affiliated State Programs/ Universities
- KEH Marketing
- Macalester College
- National Society of Black Engineers
- REpowering Schools
- Saint Paul Public 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 future energy leaders, engineers, scientists, innovators, and problem-solvers.

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

We would like to especially recognize the following sponsors whose generosity and commitment to the KidWind vision has made this work possible. In the last 5 years, these organizations have each donated over $150,000 towards KidWind's goal of bringing renewable energy education to classrooms around the world.

Vernier is our most significant supporter and partner. In addition to supporting Challenges and workshops across the U.S., Vernier holds exclusive license to produce KidWind branded wind and solar gear. We love their generosity and insights and hope to continue improving old products and inventing new ones with their team for years to come.

KidWind has been working with EDP Renewables since 2013 to bring wind energy education to the many communities across the U.S. where EDPR is at work. They are frequent sponsors of workshops, challenges and our REcharge Academies.

KidWind has been working with Pattern Energy for the last three years in Canada and the U.S. In addition to funding workshops and Challenges, they are always eager to support our out-of-the-box ideas and have helped us to develop new and experimental projects like the Power Grid Kit.

For over 10 years, KidWind has been generously supported by NREL as part of the Wind for Schools and Collegiate Wind Competition programs. Their support is used for outreach, the development of new materials and in supporting our annual National KidWind Challenge.

2018-2019 National KidWind Challenge Sponsors

2018-2019 State Level KidWind Challenge Sponsors

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.

History of the KidWind Challenge

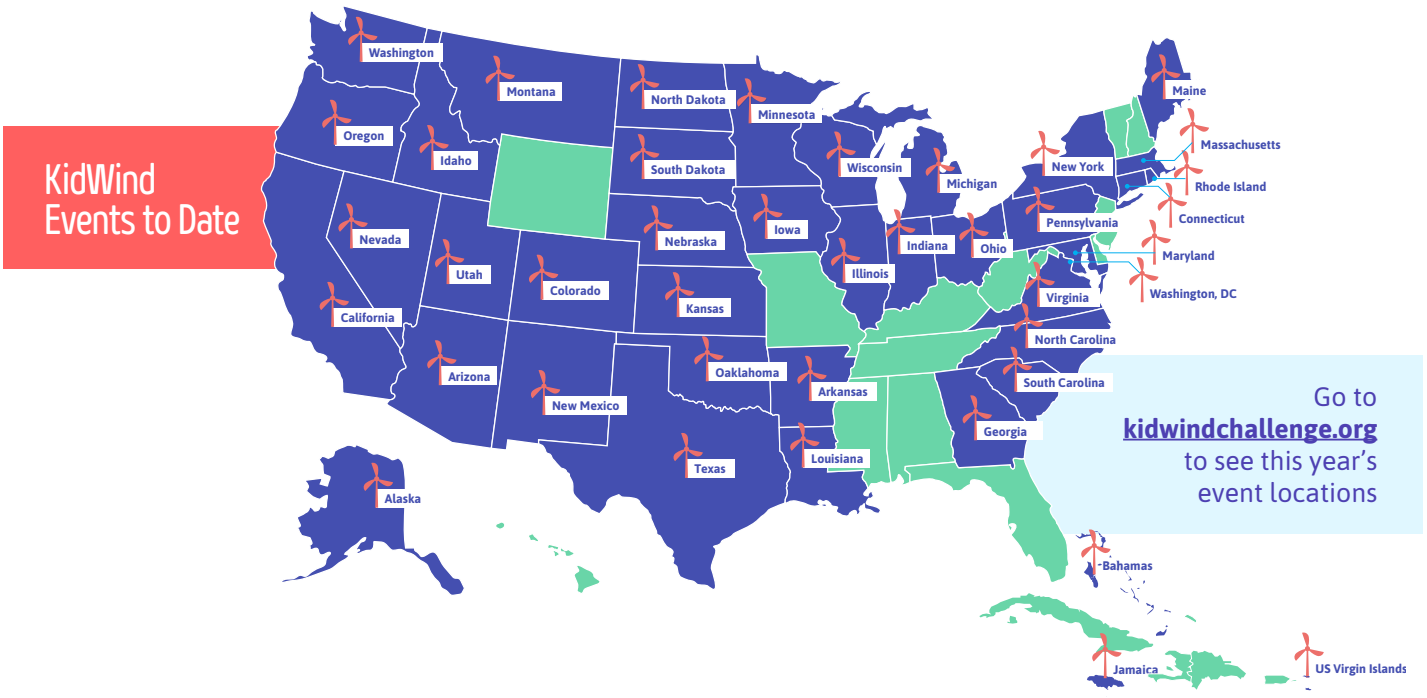
Since 2009, KidWind Challenge events have been successfully implemented in 26 states, with roughly 35,000 students competing in 227 events across the country to date.

Our 2018-2019 Challenge season was the biggest year yet!
Last year we saw:

- 35 Regional KidWind Challenges in 22 States
- 125+ Local workshops, classroom visits, outreach events
- 1000 Teams and 5000+ students directly involved in Regional and Online Challenges
- 80 Teams totaling 300 students attending WINDPOWER 2019 in Houston, TX

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 in the renewable energy industry.



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.

Online Challenge (Wind & Solar)

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.

Event Challenge (Wind & Solar: Depending on Event)

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. To find details about your local event, check out the Events page for your particular event and/or contact the local organizer.

National Challenge (Wind Only, For Now!)

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 2020.

Who Can **Participate?**

Online Challenge

Any student from anywhere in the world can participate in the online challenge. There are no age or materials restrictions, as long as you are safe!

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.

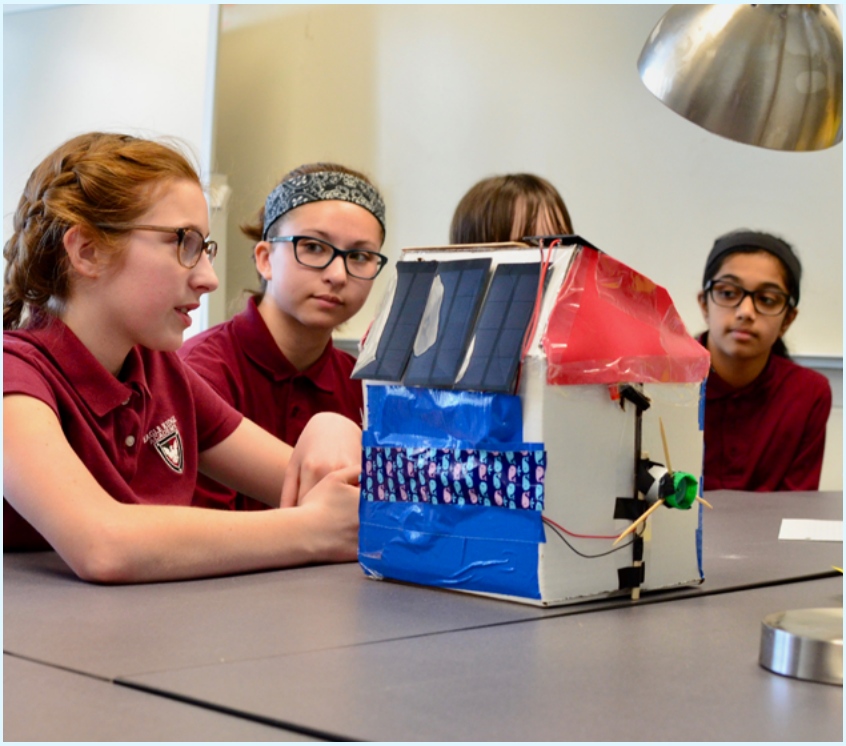
Most events follow our general rules and rubrics, but there maybe some variations in schedules, events, judging, and instant challenges. Please contact your local organizer for details about your specific event.

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.

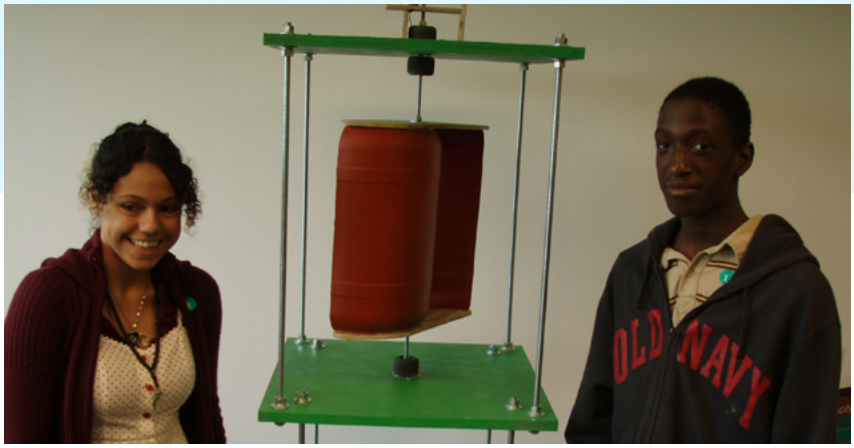
We can only imagine what the next ten years will hold!

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:

- American Wind Energy Association - The trade group of the wind industry. www.awea.org
- Department of Energy - Wind. www.energy.gov/science-innovation/energy-sources/renewable-energy/wind
- National Renewable Energy Lab - Wind. www.nrel.gov/wind/
- Understanding Wind - Very detailed answers to many wind questions. www.macalester.edu/understandingwind/questions.html
- Wind with Miller - http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/kids/index.htm



Participation **Checklist**

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

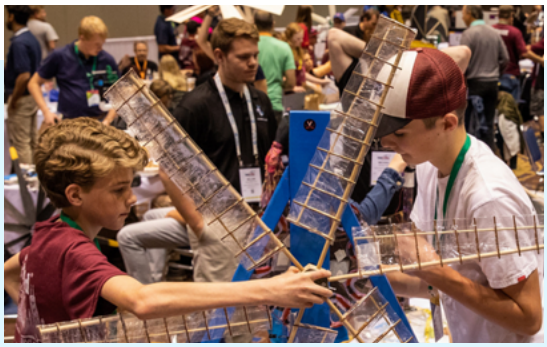
KidWind Wind Challenge Online

- ☐ 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
- ☐ If there is a KidWind Challenge workshop nearby, send your coach!
- ☐ 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.



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 school-sanctioned trip.
- → A team member cannot attend due to illness or family crisis.

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:

- 4th to 8th grade
- 9th to 12th grade
- Elementary: Weightlifter Challenge

Note: Not all divisions will be available at every challenge. Check the website for event specifics.

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
- 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.

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)

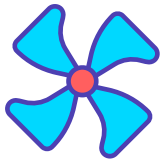
The easiest path is to get a few **KidWind Turbine Generators from Vernier.** If you use this generator, you will be in the KIDWIND GEN division.

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!

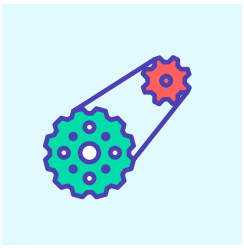
Advanced Generators (OPEN DIVISION)

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

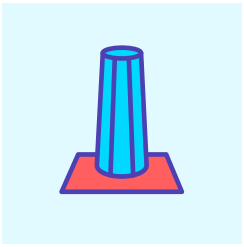
Wind turbine blades and their orientation to the wind are very important parts of a wind turbine design. You could study this for years and still not be an expert! The only rule we have about blades is you cannot use pre-made airfoils and your blades should be made of safe materials. We see students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



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!



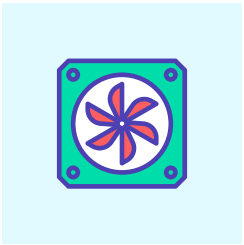
Towers

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. **KidWind.org**

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 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 pre-manufactured gearboxes and other parts, but keep in mind that innovation is a critical judging criteria, and parts that you make on your own will earn you more points.

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 is unable to collect data.

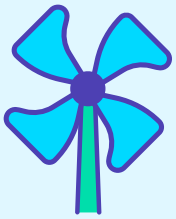
9. You cannot use pre-manufactured wind turbine blades or airfoils/sheets.
10. Your wind turbine must be free-standing. A tower/stand will not be provided.
11. Metal, plexiglass, and similar blade materials are highly discouraged because they are potentially dangerous. On occasion, we have allowed these 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

How Your **Turbine Will Be Tested**

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.

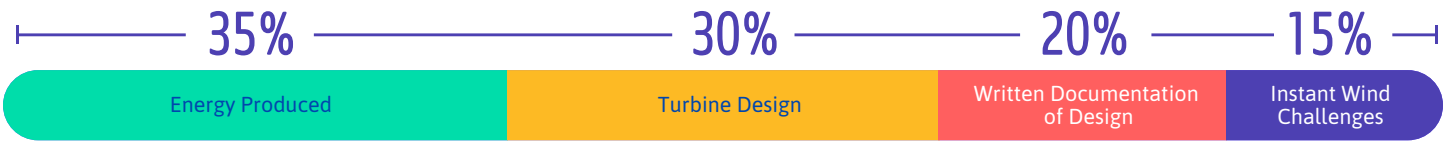


Turbine Testing

- 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 data-logging 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.

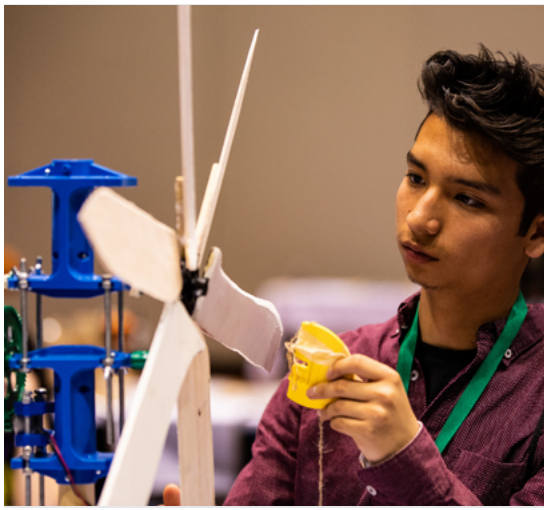
Rank Method

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 apart after the competition and reuse the parts?

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.

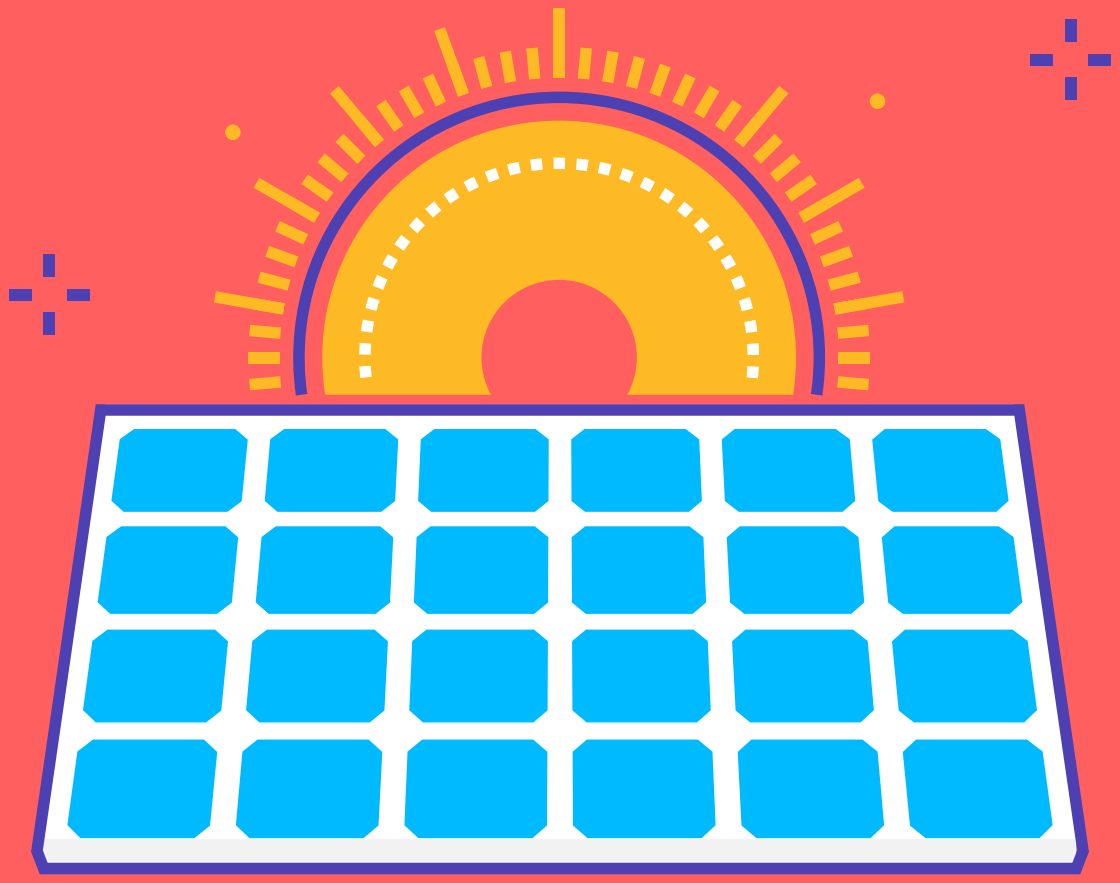
Instant Wind Challenges (15%)

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.



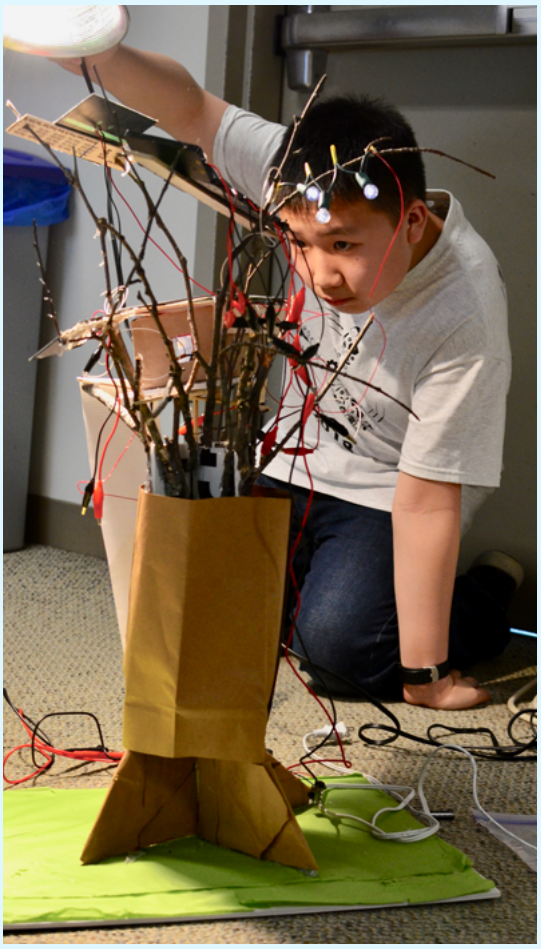
Solar **Challenge**

Introduction

After 10 years of holding KidWind Challenges, we have decided to broaden our offerings to explore solar. Our trial solar challenge events in 2018 and 2019 were so much fun we are now allowing all sites to offer a solar device design challenge. Check the website to see if one is offered near you! We strongly believe this component will motivate new and different students to engage with renewable energy.

Teams that enter this challenge need to construct a solar powered device and bring it to a Solar Device Design Challenge. Think model house, ferris wheel, phone charging tree, machine, car — whatever you want! Judges will examine your device, see if it works, and ask you questions about your design and process. Your solar device will be evaluated on your thoughtful, creative, and resourceful design, the innovation and complexity of your circuitry, your reflections on the construction process, and what you may have learned about solar power. If there are no solar challenges near you, upload your details to the Online Challenge and see if you are selected as a monthly winner!

This challenge has borrowed ideas from Jr. Solar Sprint, Green Dollhouse Challenge, Solar Decathlon and the REcharge Labs Solar House Challenge. Thanks to everyone for their imagination and creativity.



Participation **Checklist**

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

KidWind Solar Challenge Online

- ☐ Explore solar devicess on the Online Challenge.
- ☐ Get some solar building gear.
- ☐ Think about what you want to build.
- ☐ Build and refine your solar device.
- ☐ Troubleshoot your solar device.
- ☐ Collect some data about your device.
- ☐ Upload information about your device and your team to the Online Challenge.
- ☐ Wait to see if you are the monthly winner.

KidWind Solar Challenge Event

- ☐ See if there is a KidWind Challenge Event nearby that has a solar competition.
- ☐ Find a coach and form a team.
- ☐ Is there is a KidWind Challenge workshop nearby? Send your coach!
- ☐ Get some solar building gear.
- ☐ Think about what you want to build.
- ☐ Build and refine your solar device.
- ☐ Troubleshoot your solar device.
- ☐ Collect some data about your device to share with judges (notebook, video, etc).
- ☐ Fill out your Solar Project Profile Form
- ☐ Get to an Event Challenge and have fun!

What do I bring to the Challenge?

- ☐ Solar Device
- ☐ Solar 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)

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 who attend.

Exceptions include:

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

Where to Get Gear to Build Your Solar Device

What you need to build your solar device depends on what you are trying to construct. At a minimum you will need solar panels. You will also want other components, like motors, lights, and wires, to make your device. All of the gear you will need can be found on the Gear page of the KidWind website!

Solar Challenge Divisions

There are two divisions:

- → 4th to 8th grade
- → 9th to 12th grade

Solar Device **Rules**

Building Guidelines

1. Size

Your solar device and all accessories must fit in a 1-meter cube. Simply having a bigger device will not boost your score. You will want to make sure you leave some space (maybe 10 to 20 cm) around the edges of your device.

2. Materials

You can use anything to construct your device. We are especially fond of repurposing found items like old dollhouses, model cars, and recycled materials. Remember that resourceful and responsible use of materials is considered during the judging process.

Pre-manufactured circuits or circuitry kits are allowed (little bits, snap circuits, etc), but will be noted in the judging process.

3. Solar Panels

You can use solar panels from any company and you can use any number of solar panels, but only use solar panels that are 6V or below and produce less than 1.1A. If you combine solar panels in parallel or series, please make sure that you are not producing more than 12V at 2.2 amps in any configuration.

- Not sure how combining solar panels affects voltage and current? A solar panel is basically a DC power source. If you combine panels in series, you will increase the voltage they can provide. If you combine them in parallel, you increase the available current they can provide.

4. Accessory Loads & Power Storage

You can use any load to make your device interesting. These can include LEDs, incandescent bulbs, motors, and capacitors. These do not have to be new items; you can dissect and scrounge things from all sorts of places. We love cutting up old holiday bulb strings and finding parts in old electronic devices. The key to using items that you find is to be sure they can be powered by the solar panels that you are using.

Pre-manufactured circuits or circuitry kits are allowed (little bits, snap circuits, etc), but will be noted in the judging process.

Safety First!!!

- Yes, you're dealing with electricity...so be careful.
- Learn a thing or two about circuitry before diving into building your solar device!
- Watch out for short circuits!
- Carefully check that each of your loads are properly connected to the power source before turning your device on.
- Use the proper solar panels for your solar device.
- High voltage alone is not going to make a light bulb brighter, it will, in fact, more likely blow it up.

We may disqualify your solar device if it is judged to be potentially dangerous. Send us a photo of your circuit if you're unsure if it is safe.

Extension Activities

High school students might consider constructing a solar panel to learn the chemistry and physics of how a solar panel works. Learn more about these challenging projects here:

- **Build a Solar Panel Kit**
- **Build a Solar Panel Kit #2**
- **UW Build a Solar Panel Info**
- **Video Solar Cell Construction**

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

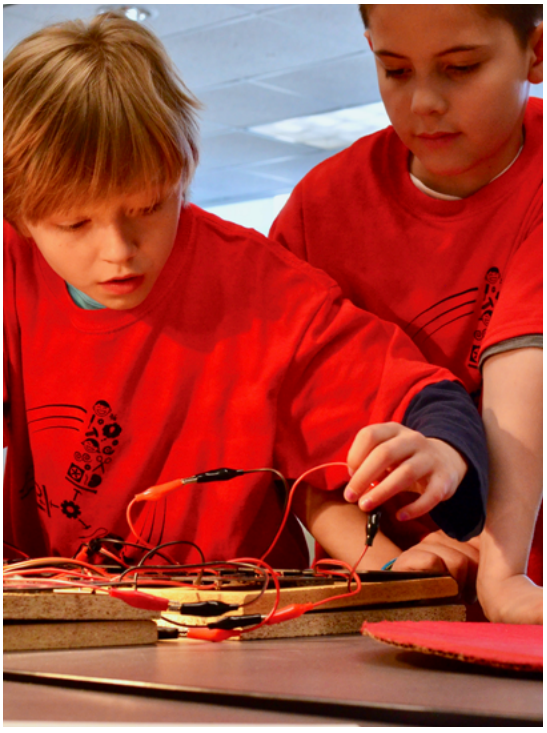
Important:

Bigger does not mean better! You do not get more points for more solar panels or more power output. It is all about design, creativity and the functionality of what you have constructed.

Resources

Some resources to learn about energy:

- → PHET Electricity Simulations -- The simple DC circuit ones are the great.
- → Combining Solar Panels
- → NeoK12 Solar Engergy
- → Go SEEK: Solar Energy Eco Knowledge



5. Microcontrollers

We think integrating a microcontroller into your solar device is awesome - but it is not easy!

Microcontrollers are small computers that you can program to make things happen in your solar device, like turning a light when it gets dark or making an elevator go up and down when you press a button. Some examples of microcontrollers include Makey-Makey, the microbit, Hummingbird Robotics, Arduinos and the lilypad.

The microcontrollers can be externally powered using a battery or plug — or for super serious bonus points, it can be powered by the sun, too.

NOTE: This could be very difficult!

6. Budget

There are no budgetary restrictions for the Solar Device Challenge, but keep in mind that resourceful and responsible use of materials is considered during the judging process. As we said before, we love to see materials that have been reclaimed.

7. Wiring Diagram

As a part of the judging and reporting process, we ask all teams to provide a wiring diagram. This will help the judges understand what you were trying to do with your solar device.

Use the Wiring Diagram template located in the appendix to detail all the electrical parts of your solar device such as solar panels, loads, switches, etc. You may either bring this form to the judges, or use it as a starter to create a more formal and detailed wiring diagram.

8. Solar Panel Placement

You can attach your solar panels directly to whatever solar device you have created or get a little more creative and flexible with your panels. You could create a solar panel bank that is not attached to your device but can power it with an attached wire or a solar panel bank that is movable so that it can pivot and capture the most direct sunlight.

Please note that all of your components should still fit within the 1 meter cube. You should also be careful that any elevated solar panels are far enough away from the overhead light bank that they will not overheat or become damaged.

While this challenge is focused around solar photovoltaic energy (PV - converting sunlight to electricity) you are more than welcome to integrate solar thermal and other solar construction concepts into your design that you can show off to your judges. This could definitely show the judges you know your stuff when it comes to solar power!

Solar Testing **Guidelines**

We hope to provide a similar solar testing experience for all teams. If we have access to natural sunshine we will use that!

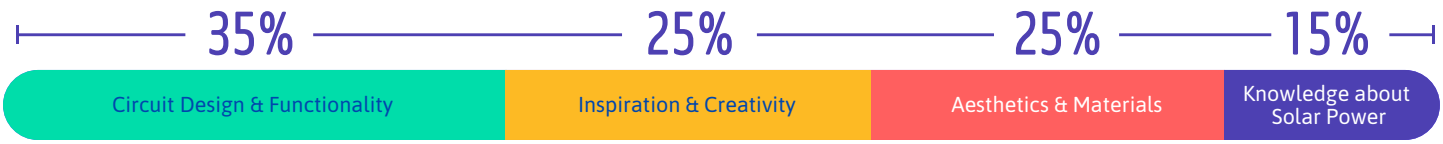
If it is a cloudy or rainy day, we will use an artificial lighting bank to test your solar array. Typically, this array will utilize a bank of 80-100W incandescent, halogen or xenon light bulbs that we can shine on your solar panels. This light array will be positioned 1 meter directly above the table.

At some testing sites we may rotate the lighting bank 180 degrees to simulate sunrise to sunset to see how your solar device performs. At some locations we may also test to see if you have any storage embedded in your solar device. For this test the judges may turn the lights off and see if your device still functions.

Please check with your event organizer for specifics about your event's solar device testing protocol.

How Your Solar Device Will be **Tested and Evaluated**

At KidWind Challenges that include a Solar Device event, teams can expect to be evaluated on the following criteria: Circuit Design & Functionality, Inspiration & Creativity, Aesthetics & Materials, Knowledge about Solar Power.



These criteria will be assessed during your interview with the judges. Please keep in mind that judging forms and categories may be different at your local event. Your local organizer will share details of how your solar device will be evaluated prior to your event.

Circuit Design & Functionality (35%)

One of the hardest parts of building your solar device is to build a solar powered circuit that works reliably. At the meeting with the judges, your device will be examined to see how the circuit diagram and design you provided on your Solar Project Profile form match up with your actual circuits. The judges will also use this time to test your device out in either the sun or under a solar lamps array to see how well it works.

Teams may want to share additional documentation with the judges to help showcase the design process and their knowledge of solar 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 (max of 4 minutes)
- PowerPoints
- Science fair poster boards

Questions the judges might ask, including:

- How many loads do you have?
- What types of loads do you have?
- Did you have to change your loads to work with solar?
- What changes have you made to your circuits over time?
- How do you feel about your circuit diagram? Does it match your circuit?
- How much power do your solar panels produce?
- Are you solar panels in series or parallel?
- What do the terms voltage, current and power mean in relation to solar PV?
- Do you have any switches in your device? Did you make them?
- Do you know the kinds of solar panels you used?
- Do you have any storage in your system?

We plan celebrate your hard work in many ways. This might involve recognizing excellence in the following areas:

- Aesthetics
- Computer Aided Design
- Design Process
- Documentation
- Economics
- Electrification
- Hand Sketching
- Innovation
- Interior Design
- Journaling
- Lighting Design
- Lighting Performance
- Local Resources
- Photovoltaic Integration
- Playability
- Re-use
- Realism
- Research Resource Sharing

Inspiration & Creativity (25%)

We really want you to think about the big picture for your solar challenge. Help us to understand why this construction is important and relevant to you, and be as creative as you can in your design and build. You may decide to take a new twist on an old item like a cell phone charger or solar car, or you may decide to invent something totally new, like a scale model of a solar powered tree house or a way to help rural villages generate light! Think big! If you cannot get your inspiration to work perfectly that is okay – the judges will appreciate your inspiration and effort.

Questions the judges might ask you include:

- Did you have an inspiration for your design? What was it?
- Were you trying to solve a problem or just make something cool?
- How many models did you make?
- In what ways is your design innovative or special?
- How much time did you spend designing?
- How did you capture your design process? Do you have drawings or a notebook?

Knowledge about Solar Power (15%)

Along your journey of building a solar powered device, we hope you are learning how solar energy works and its importance to our energy future. During your interview, judges may ask you questions to check this understanding.

Judges might ask the following questions:

- How might we use solar energy to power our society?
- What are the challenges and benefits of a solar powered world?
- What is the difference between solar thermal and solar PV?
- What are the differences between the various types of solar panels?
- What careers are related to solar power?

See the Big 10 Renewable Energy Questions for more guidance on what questions to be thinking about!

Aesthetics & Materials (25%)

This is where the rubber meets the road. We can all think up cool ideas in our heads — the key is can we build them? The judges will want to see how much care you have used in building your device. Judges will also be looking for teams that use recycled materials — they love that. In the solar challenge, it isn't the team that uses the most solar panels or builds the biggest device that will impress the judges. What will most impress the judges are devices that showcase the team's inspiration, are well constructed, and function!

As they examine your device, judges will be considering the following questions:

- Is the device well built?
- Did they take their time building the device?
- Is it neat and tidy?
- What materials did they use?
- Where did they get their materials?
- Did they try using a microcontroller?
- How much time did they spend constructing their device?

The judges might ask you the following questions:

- What are you most proud of in your device?
- What was the hardest part of your device to get working?
- How would you change your device if you had more time?
- What things would you like to learn more about?

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?

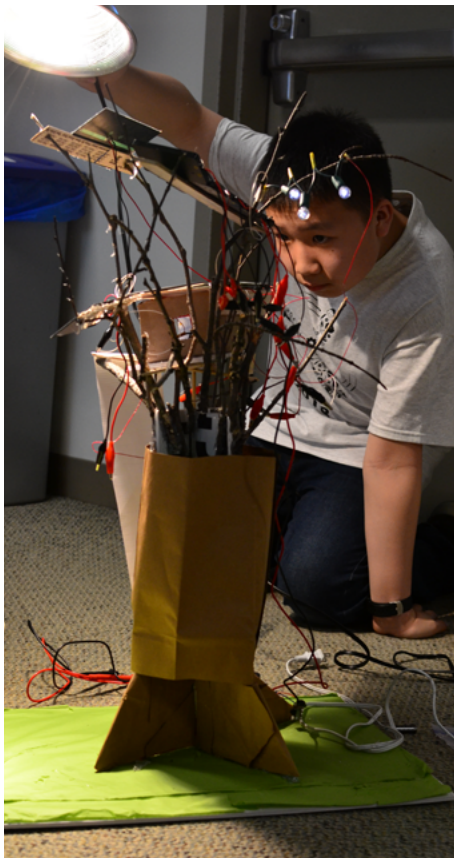
3. What is climate change and how can renewable energy impact this phenomenon?

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 voltage 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.

_____

_____

Solar 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 solar device. You should present this document to the judges at your KidWind Challenge event.

1. **Does your device fit in the 1m square cube?**

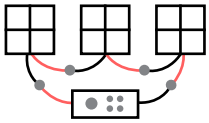
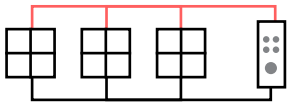
☐ Yes ☐ No

2. **Number of Solar Panels:** _____

3. **What is the rated size and output of each solar panel?** _____

_____

4. **Are your panels wired in series or parallel?** (circle one)

series:  parallel: 

5. **Are your panels attached to your device or are they in a separate bank?** (circle one)

6. **Can your panels move to track the sun if needed?**

☐ Yes ☐ No

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

- Your solar powered device
- This form!
- Any notebooks, drawings, videos that you kept while building your structure
- Wiring Drawing that details your circuit

Loads

Describe all your loads.

Load	How Many?

1. Which loads use the most power?

_____

2. Which loads use the least power?

_____

3. Describe any switches you have integrated into your device.

_____

Don't forget to prepare a wiring diagram. You can do this by completing the diagram template found in the Rulebook Appendix.

Solar 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 solar device. You should present this document to the judges at your KidWind Challenge event.

1. **Does your device fit in the 1m square cube?**

   ☐ Yes ☐ No

2. **Number of Solar Panels**:_____

3. **What is the rated size and output of each solar panel?** _____

   _____

4. **Are your panels wired in series or parallel?** (circle one)

5. **Are your panels attached to your device or are they in a separate bank?** (circle one)

6. **Can your panels move to track the sun if needed?**

   ☐ Yes ☐ No

7. **Max Voltage Output of your Solar Array** _____ V

8. **Max Current Output of your Solar Array** _____ A

9. **Total Maximum Power Output of your Solar Array** _____ w

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

- Your solar powered device
- This form!
- Any notebooks, drawings, videos that you kept while building your structure
- Wiring Drawing that details your circuit

Loads

Describe all your loads.

Load	How Many?	Current Draw per 1 Unit

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

10. **If all the loads in your device are powered on what is the power and current consumption?**

_____

11. **Detail any methods you have utilized for reducing the power consumption of your loads.**

☐ No consumption reduction plan.

_____

_____

12. **We may turn off the lights as we test your solar device to test your device's ability to store electricity. Describe any mechanisms or capacitors you have used to store electricity?**

☐ No electricity storage.

_____

_____

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

☐ No microcontroller.

_____

_____

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

☐ No advanced manufacturing.

_____

_____

Don't forget to prepare a wiring diagram. You can do this by completing the diagram template found in the Rulebook, through a digital program, or through other inventive ways. Just make sure the diagram allows the judges to tell what circuitry is happening within your device!

Circuit **Diagram**

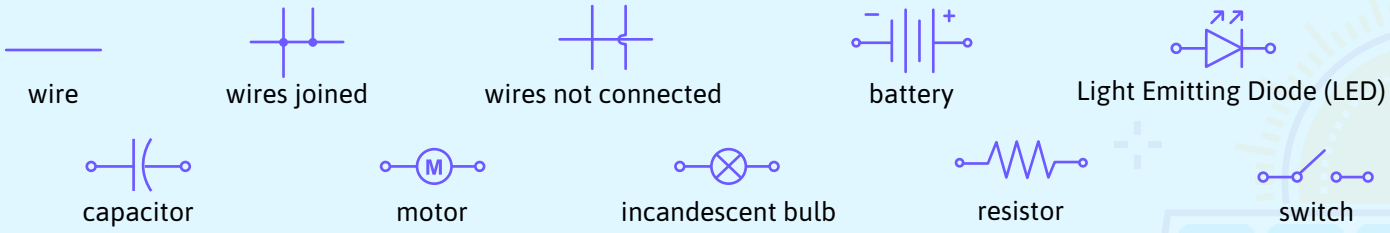
Team Name: _____ School Name:_____

NOTE: While you are required to submit a circuit diagram to your judges, you do not have to use this document. You may adapt this template and provide a more detailed, complex circuit diagram.

Draw your diagram in the box below:

Reminder: All lines in a circuit diagram must be straight and neatly drawn!

Here are some symbols you may want to include in your diagram:



For more information and additional circuit symbols check out:

- https://learn.sparkfun.com/tutorials/how-to-read-a-schematic/
- https://electronicsclub.info/circuitdiagrams.htm
- https://www.rapidtables.com/electric/electrical_symbols.html