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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

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 the workforce of our clean energy future. We invite you to share in our passion to inspire these future leaders, engineers, scientists, innovators, and problem-solvers of our energy future. Please contact michael@kidwind.org to become a 2019-2020 sponsor. To see this year’s KidWind Challenge Sponsors visit the website.

2019 NATIONAL KIDWIND CHALLENGE SPONSORS

2019 STATE LEVEL KIDWIND CHALLENGE SPONSORS

→ 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

→ Arthur Morken  
→ Carl Joseph  
→ Colleen McDaniel  
→ Curtis Morgan  
→ David Barrett  
→ 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  
→ Lynn Shellenberger  
→ Meghan Phadke  
→ Michael Phalen  
→ Peter Zack  
→ Richard Anderson  
→ Remy Pangle  
→ Ray Pitcher

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!

A NOTE ON REPRODUCTION

This work may not be reproduced by mechanical or electronic means without written permission from KidWind, except for educational uses by teachers in a classroom situation or a teacher training workshop. For permission to copy portions or all of this material for other purposes, such as for inclusion in other documents, contact Michael Arquin at michael@kidwind.org.
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 structures that they test, and then meet with a panel of judges to present their design process and demonstrate their contextual knowledge of 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 of 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 2018-19 Challenge season was the biggest year yet! Last year we saw:

- 35 Local KidWind Challenges in 22 states
- 125+ Local workshops, classroom visits, and outreach events
- 1000+ Teams and 5000+ students involved in regional and online challenges
- 80 teams and 300+ students attending Nationals in Houston

**WHAT IS THE KIDWIND CHALLENGE?**

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.
You can participate and prepare for KidWind Challenges in a 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 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 structures, 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 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 rules as to age or materials!

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 an 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 information 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 structure. 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 structures.

→ 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 Structure, 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
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 structures 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!
**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)
- ☐ Before you go to the Event Challenge try the Online Challenge
- ☐ Plan how you will get to the Event Challenge
- ☐ Get to Event Challenge and have fun
- ☐ If you place in the top two, get an invite to the National KidWind Challenge

**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.
WIND CHALLENGE DIVISIONS

The wind challenge is divided into different grade level and generator-type 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.
The following are some important questions about wind energy. Use our resources or do your own research to see if you can answer them.

1. **How can wind power impact climate change?**
   Climate change is a major challenge facing the world. What are the environmental benefits of generating electricity using the wind? What are some of the tradeoffs? Why would we want to harness the power of the wind? What challenges might we face in generating 20% to 30% of US electricity from wind?

2. **What causes wind?**
   Where does wind come from? What are the windiest parts of the US? Where are most of the wind turbines located in the US? Are there any offshore wind farms? Why would you want to put a wind farm offshore?

3. **What kinds of devices transform the power of the wind?**
   Devices that capture the energy in the wind come in many different forms: sailboats, kites, pinwheels, and so on. There are windmills to pump water and grind grain, there are wind turbines for your home and for the electrical grid, and there are vertical and horizontal axis machines. What defines each of these kinds of turbines? What are some important ways that they are similar and different? What makes your wind turbine similar to these devices? What makes your wind turbine different?

4. **How can we calculate power in the wind?**
   What is the equation that defines how much power is in the wind? What are the most important variables? How does this equation effect turbine design and placement?

5. **How do we deal with wind variability?**
   Wind turbines can only generate power when the wind is blowing, just as solar panels only generate power when the sun is shining. As we all know, the wind does not always blow and the sun does not always shine. How can we deal with the “variability” of renewable energy resources? How can we ensure that we have power whenever we need it without relying on fossil fuels? How could the science of meteorology impact these questions?
6. **Where does our electricity come from?**

   From what sources do we generate most of our electricity in the US? What are the primary sources of electricity used in your region of the US? How much does it cost to power your house each month? How much of the electricity that is used in the US is generated by wind? Has this changed over the last ten years?

7. **What are some of the negative impacts of wind power?**

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

   → **Sound.** People who live near wind turbines sometimes complain that the sound from the wind turbines is causing health impacts from vibration and other acoustical effects.

   → **Aesthetics.** Wind turbines can be an eyesore to some people.

   → **Environmental Impact (Habitat).** Wind turbines can change local habitats and have caused significant bird and bat kills in the past.

8. **How do we pay for wind power?**

   As wind and solar power are relatively new energy sources to the US, they receive financial support to make them more economical. Fossil fuels and nuclear power receive subsidies as well. Do you feel that subsidies are appropriate in the energy industry? If you feel that subsidies are okay, what energy sources would you subsidize and why?

9. **What does the future of wind energy look like?**

   A great deal of research is going into making wind turbines more efficient. What components of wind turbines are undergoing rapid change and development? Which changes seem to be having the most impact in improving turbine performance?

10. **What careers are there in the wind energy industry?**

    Developing and installing renewable energy, like wind and solar, requires professionals and experts from many different fields of study. What are some of the careers and jobs that make renewable energy possible? What do you need to study to work in these fields?
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 (KW-GEN)

The easiest path is to get a few KidWind Wind Turbine Generator (KW-GEN) from Vernier. If you use this generator, you will be in the KIDWIND GEN division.

Homebuilt Generators

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

In the 2018-2019 season, we will allow teams to use any AC or DC generator they can find to power their turbine. We have a list of a few we have tested on the KidWind Challenge website, but don’t let our list limit your imagination. Feel free to explore!

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. use simple box fans many times. 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. www.kidwindchallenge.org/
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 have three choices for the type of generator that you can use in your turbine:
   - 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.
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. We have allowed these as the blades mounted to them as these 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.

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.

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.
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%)

Students should produce some type of documentation that reflects their design process and their knowledge of wind energy science. It is up to each team to determine how they want to document this part of their project. In the past we have seen:

→ Short reports
→ Engineer’s 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
After 10 years of holding KidWind Challenges, we have decided to broaden our offerings to explore solar. With our partners at REcharge Labs, we have been engaging in solar education programming, and are ready to bring this work to your Challenge events. Our trial events in 2018 were so successful, we’ve decided to make it official this year! 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 Structure Challenge. Think model house, ferris wheel, phone charging tree, machine, car — whatever you want! Judges will examine your structure, 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 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 structures on the Online Challenge.
☐ Get some solar building gear
☐ Think about what you want to build.
☐ Build and refine your solar structure.
☐ Troubleshoot your solar structure.
☐ Collect some data about your structure.
☐ Upload information about your structure 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 structure.
☐ Troubleshoot your solar structure.
☐ Collect some data about your structure to share with judges (notebook, video, etc).
☐ Get to an Event Challenge and have fun!

SOLAR CHALLENGE DIVISIONS
There are two age divisions:
→ 4th to 8th grade
→ 9th to 12th grade

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 STRUCTURE
What you need to build your solar structure depends on what you are trying to construct. At a minimum you will need solar panels.

Our partners at Vernier have solar panels and few solar items that we think are pretty great. Check them out at www.vernier.com/products/kidwind/solar-energy/

You will also want other components to make your invention, like motors, lights, wire. Our website has a list of cool parts and vendors to will help you build a super fantastic device.
SOLAR STRUCTURE RULES

BUILDING GUIDELINES

Size
Your solar structure and all accessories must fit in a 1-meter cube. Simply having a bigger structure 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 structure.

Materials
You can use anything to construct your structure. 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.

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.

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

SAFETY FIRST!!!

→ Yes, you’re dealing with electricity...so be careful.
→ Learn a thing or two about circuitry before diving into building your Solar Structure!
→ 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 House
→ 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 House if it is judged to be potentially dangerous. Send us a photo of your circuit if you’re unsure if it is safe.

Local judges have the final call for safety. If you’re not sure about something, send a photo to info@kidwind.org
Accessory Loads & Power Storage

You can use any other loads to make your structure or design interesting. These can include LEDs, incandescent bulbs, motors, capacitors. These do not have to be new items; you can dissect and scrounge things from all sorts of devices.

Microcontrollers

If you want to integrate a microcontroller that is fine (think Makey-makey, microbit, Hummingbird Robotics, Arduino). The microcontroller can be externally powered or for super serious bonus points, it can be powered by the sun as well. NOTE: This could be difficult!

Budget

There are no budgetary restrictions for the Solar Structures 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.

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!

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 Solar PV:

→ PHET Electricity Simulations -- The simple DC circuit ones are the great.
→ Combining Solar Panels
→ NeoK12 Solar Energy
→ Go SEEK: Solar Energy Eco Knowledge
HOW YOUR SOLAR STRUCTURE WILL BE TESTED AND EVALUATED

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

These criteria will be assessed during your interview with the judges. 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 solar structure will be evaluated prior to your event.

CIRCUIT DESIGN & FUNCTIONALITY (35%)

One of the hardest parts of building your solar structure is to build a solar powered circuit that works reliably. During this part of the interview the judges will examine your circuit diagram, your design profile sheet, and your actual circuits to see how well they match up. They will also put your device either in the sun or under a solar lamps array to see how well it works. This part of the interview is probably to most detailed. The judges will want to see if you understand how your circuit works!

Questions the judges might ask you include:

→ 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 structure? 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
→ Journal
→ Lighting Design
→ Lighting Performance
→ Local Resources
→ Photovoltaic Integration
→ Playability
→ Re-use
→ Realism
→ Research Resource Sharing
KNOWLEDGE ABOUT SOLAR POWER (15%)

Along your journey of building a solar powered structure, 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 are the careers are related to solar power?

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 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?

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 structure that will impress the judges. What will most impress the judges are structures 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 structure?
→ 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 structure?

The judges might ask you the following questions:

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

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<th>Coach</th>
<th>Team Name</th>
<th>Division</th>
<th>Student Names</th>
<th>Notes</th>
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### MASTER SCHEDULE (FOR EVENT ORGANIZER)

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<th>15 mins – 1 team Turbine Judging</th>
<th>30 mins – 4 teams Instant Challenge #1</th>
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<th>30 mins – w4 teams Knowledge Test</th>
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# Solar Structure Design Profile

*Note: This document is meant to help guide your design process and provide documentation for your final structure. You should present this document to the judges at the Challenge.*

**TEAM NAME: ______________________________**

**SCHOOL NAME: ______________________________**

**LEVEL:**  
☐ 4th-8th Grade  ☐ 9th-12th Grade

Congrats on constructing a cool solar structure. Please fill out this form (or just create your own document) to the best of your ability before you talk the judges. You will give this form to the judges when you meet with them, so please have one clean copy for them at that meeting.

## Here is what the judges will want to see:

- Your structure
- Solar Structure Design Profile
- Any notebooks, drawings, videos that you kept while building your structure

## Solar Panel Details:

- Number of solar panels __________
- Solar panel type(s) used: 
  - Monocrystalline, Polycrystalline, Thin film
- Rated voltage (V) of a single solar panel (usually on the back of the panel or on the packaging):
  ________________
- Rated amperage (mA) of a single solar panel (usually on the back of the panel or on the packaging):
  ________________

## Total Number of Loads _________

### Switch Details

- Number of switches used: __________
- Did you make the switches?  ☐ Yes  ☐ No

Describe the types of switches you used and what they’re connected to:

### Circuit Schematic

Draw a schematic of your circuit out on a piece of paper. This should illustrate inputs, outputs, power source, and circuit layout. This allows us to see how your circuit functions fully, since we can’t see the whole thing in your house!

## Loads in your Structure:

Describe the types and quantities of loads you used in your device. This might include LED Christmas lights, incandescent Christmas lights, motors, buzzers, capacitors, and/or something we didn’t think of! Tell us everything you’d like us to know about these loads!

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KidWind Challenge Rule Book 33
WIND TURBINE POWER OUTPUT SHEET

TEAM NAME: ____________________________________________ LEVEL: □ 4th-8th Grade □ 9th-12th Grade

TYPE OF GENERATOR: □ KidWind Gen Division □ Open Division (Homebuilt) □ Open Division (Other)

Note: To be in the KIDWIND GEN DIVISION, a turbine must use the KidWind Generator from Vernier(KW-GEN). All other generators, homemade generator, or another generator will be in the OPEN DIVISION. If the judges cannot verify the type of the generator, you will be placed in the OPEN DIVISION.

☐ Power is generated solely by wind created by the wind tunnel.
☐ Turbine only has one generator.
☐ Turbine is either vertical or horizontal axis.
☐ Wind turbine is free standing (cannot be attached to tunnel).
☐ No airfoils or premanufactured blades.
☐ Wires at the bottom of the turbine are labeled negative and positive.
☐ The rotor diameter of the turbine is less than 48 inches and fits inside the wind tunnel.
☐ Any shrouds must fit completely inside the tunnel.

Turbine Power Performance

Energy Output - 30 Second Trial

Some sites may have time to offer more or less than three runs. This depends on number of teams and how much time is available for tunnel testing

TEST #1: ____________________________________________

TEST #2: ____________________________________________

TEST #3: ____________________________________________

Most sites will use your highest score as your final score power score in the tunnel.

IMPORTANT: KidWind Generators will only compete with other KidWind Generators for energy output points. Homebuilts and Advanced Generators will compete separately for energy output points.
Blades (0-15 points) ________

→ What was the engineering process for blade design?
→ Do the blades appear sturdy?
→ Are blades shaped as Airfoils, Twisted, Flat?
→ How did the team determine: pitch of blades, # of blades, length, material, etc?
→ Was there a great deal of experimentation? Does the team have documentation?

Drivetrain (0-15 points) ________

→ Direct drive, geared, or pulley system? Why did they choose the system they used?
→ What materials did they use to construct drivetrain?
→ What were the major challenges with the drivetrain?
→ How did the team deal with the High Speed and Low Speed Tunnel? Did they anything different?

Generator (0-10 points) ________

→ Do they have a KidWind Generator?
→ Did they build their own generator and load system?
→ Did they use some other kind of AC / DC Generator?
→ Do they seem to understand the differences between AC/DC and loads?

Innovation (0-10 points) ________

→ How creative were the students in the construction and materials used in their turbine?
→ Did they try a vertical or horizontal axis? Why?
→ Did the students use any CAD or 3D printing?
→ Is their turbine design different than others? Is it creative while still functional?
→ How many design iterations did they discuss?
→ Did they construct their own generator? Do they understand how it works?
Independence (0-10 points) ________

→ Do you feel that the students did this work themselves?
→ Do you feel that they applied concepts they learned?
→ If they did any CAD work or 3D printing, is it clear they did the work and not a coach or parent?

Overall Appearance and Material Selection (0-10 points) ________

→ What types of materials were used to build the turbine? New? Recycled?
→ Were students careful not to use any prefabricated kits?
→ How much did their turbine change from regional competition?
→ Does it look like students were precise in their turbine building? Is it a nice looking rig?

Type of Document and/or Presentation (0-10 points) ________

→ What kind of documents did the students share? Was it a short report, engineering notebook, video, poster?
→ What is your overall feeling about the document or presentation?
→ Is it interesting and organized?
→ Was it creative? (It does not have to be; we are more interested in looking for evidence of a PROCESS of learning.)
→ Is the statement thoughtful and does it show evidence of their work?

Depth, Complexity and Clarity (0-10 points) ________

→ Did the document show a progression of discovery?
→ Did it provide evidence that students made changes based on their research and/or discoveries?

Delivery (prepared or improvised) (0-10 points) ________

→ Was the documentation and/or presentation neat and organized?
→ Do you feel that the students practiced?
→ Did all students take part in the discussion? Or did one student dominate?
→ Do you feel like the students “knew their stuff” or were they just reading or making it up?

Total Points (0-100) ________
WIND TURBINE OVERALL SCORE SHEET

TEAM NAME: _______________________________________________ LEVEL: ☐ 4th-8th Grade ☐ 9th-12th Grade

TYPE OF GENERATOR: ☐ KidWind Gen Division ☐ Open Division (Homebuilt) ☐ Open Division (Other)

_____ Judges & Documentation Score (typically 50% of score)

____ Blades
____ Drivetrain
____ Innovation
____ Independence
____ Overall Appearance & Material Selection
____ Type of Document and/or Presentation
____ Depth, Complexity & Clarity
____ Delivery (prepared or improvised)

_____ Power Output (typically 35% of score)

____ Highest Energy Output (Joules or W/s)
____ Highest Energy Output in OPEN DIVISION
____ Highest Energy Output in KIDWIND GEN DIVISION
____ Ratio of Your Output to Highest
____ Rank

_____ Instant Challenges (optional) (typically 15% of Score)

____ Score on Instant Challenge #1
____ Score on Instant Challenge #2

OPTIONAL:

_____ Knowledge Test (scored as per discretion of organizer)

Overall Comments

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KidWind Challenge Rule Book 37
SOLAR STRUCTURE JUDGING SHEET

TEAM NAME: ______________________________ SCHOOL NAME: ______________________________

LEVEL:  [ ] 4th-8th Grade  [ ] 9th-12th Grade

Structure Checklist
→ Did the team provide you with a completed Design Profile Form?
→ Does the structure abide by the 1-meter cube dimension rule?
→ Did the circuit work with sunlight? DC power supply? Lamps?

Inspiration & Creativity ________ 0 to 25 Points

Circuit Design & Functionality ________ 0 to 35 Points

Aesthetics & Materials ________ 0 to 25 Points

Knowledge about Solar Power ________ 0 to 15 Points

Total Points (0-100) ________