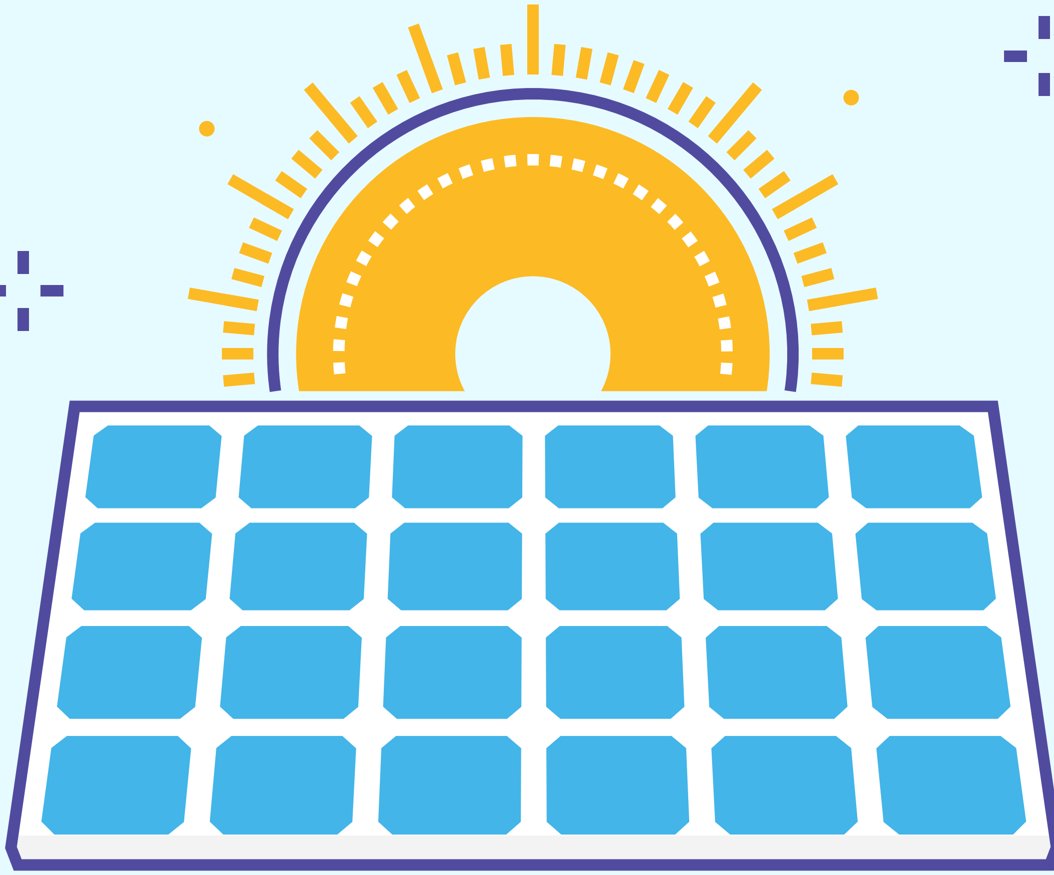
KidWind PROJECT



2024-2025 KidWind Challenge

SOLAR EDITION

GUIDEBOOK

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Dedication

Without some important visionaries, the KidWind Challenge would not be the success it is today. These organizations and individuals helped us start something great. We thank them for their passion, energy, and continued support.

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

Partners & Volunteers

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

Thank you to the individuals who have contributed to the Solar Challenge!

- Asia Ward
- Amber Cesare
- Stephanie Klixbull
- Dave Yaffe
- Keith Dent
- Susan Stewart
- Colleen Fisk
- Diane Painter
- James Brown
- Kathy Jackson
- Meghan Phadke
- Remy Pangle
- Tyler Katzmar
- Yvonne Cook
- Zella Lobo

Educators, Students and Parents

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

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.

Thank you to our **2024 Sponsors!**

While KidWind self-supports a few Challenge events around the country, our impact would be greatly limited without grants and sponsorships from clean energy industry organizations and foundations. Sponsoring a KidWind Challenge demonstrates an investment in our clean energy future.

Gale Force ($50,000+)

High Flyers ($25,000+)

Wind Riders ($10,000+)

KidWind's **Mission**

The KidWind Project, a program of the 501c3 non-profit organization Gale Force Education, has been working with educators to integrate clean energy into classrooms since 2004. As the world is increasingly powered by clean energy, it is more critical than ever to develop a workforce and public who understand the complexities of this new power generation.

KidWind's mission is to empower educators and students to explore and engage with the challenges and opportunities of a clean-powered future.

Our primary goal is to help students find their place in a clean-powered future and help the public to better understand the impacts of clean power. The two primary challenges facing clean energy adoption are the lack of a knowledgeable and skilled clean energy workforce and public opposition to clean energy development.

We are addressing these challenges by working with educators within current frameworks to increase their capacity to teach about a wide range of clean energy concepts.

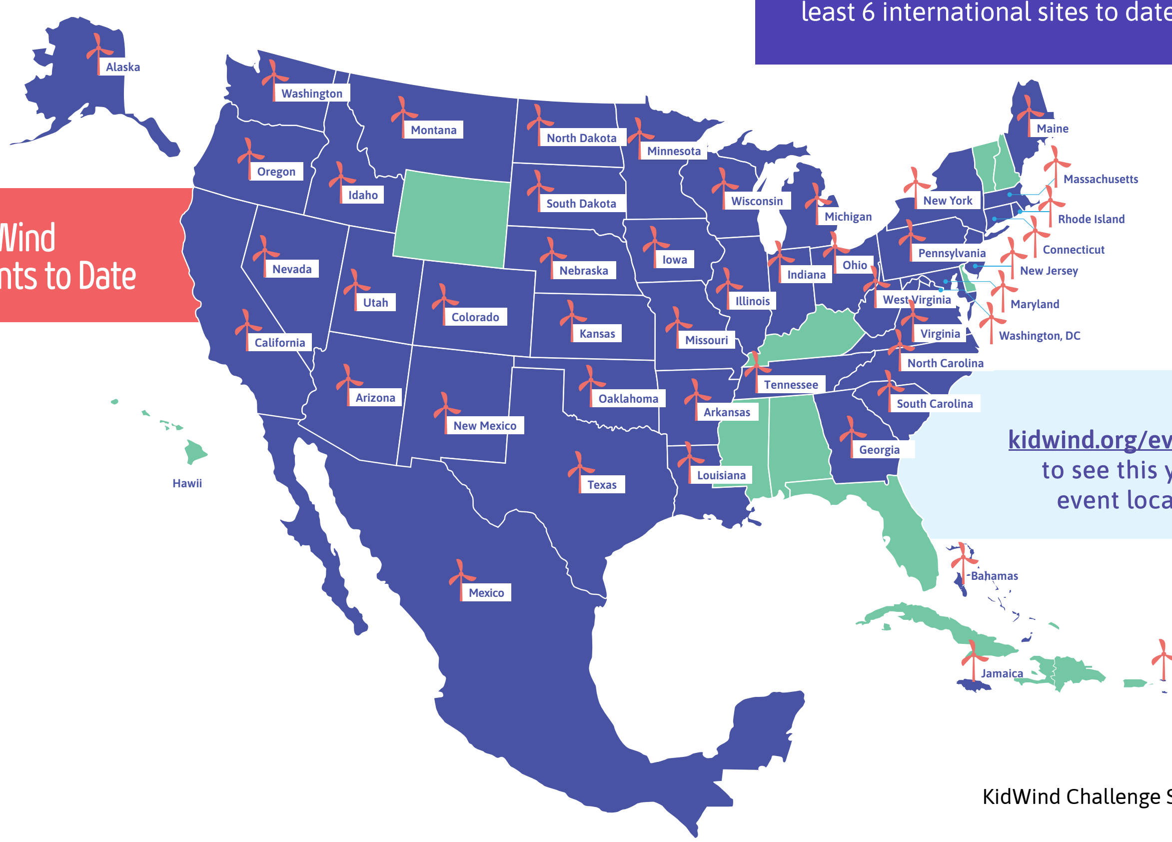
What is the KidWind Challenge?

The KidWind Challenge is a hands-on design competition where student teams showcase their small-scale wind turbines and solar home designs with the primary goal of providing a space for students to demonstrate their knowledge, skill, creativity, and passion for clean energy to their communities, industry, and the wider public.

Student teams design and construct small-scale wind turbines or solar homes that they test, and then meet with a panel of judges to present their design process and provide documentation. Teams also demonstrate their conceptual knowledge on clean energy and engage in a variety of Instant Challenges to demonstrate their 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 clean energy education accessible in classrooms around the world. Since 2009, KidWind has hosted hundreds of Challenges in 39 states and at least 6 international sites to date.

KidWind Events to Date



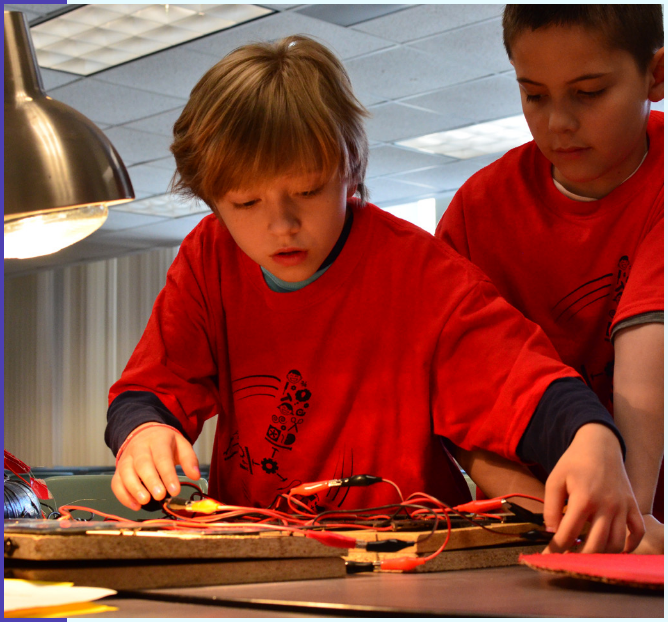
Go to **kidwind.org/events/** to see this year's event locations

What is the **Solar Challenge?**

The Solar Challenge is a recent addition to KidWind's (Wind) Challenge events, the first running alongside an In-Person KidWind Challenge in 2018. Many teachers leading KidWind Challenges have expanded their events to include a Solar Challenge. The name of the Solar Challenge may have changed over the years, but the goal has always been to encourage creative applications and innovations in the design of solar devices while learning how to work with solar photovoltaics (PV). In this way, the Solar Challenge is a STEAM (science, technology, engineering, art, and math) activity, drawing on the arts and humanities to design and creatively solve problems while learning and building with STEM skills.

The Solar Challenge Theme is "Solar Home"

Student teams in grades 4th-12th participate in age-level divisions to create a solar powered project on the theme Solar Home. A solar home is a type of structure that considers the environment, the inhabitants, and its functional and aesthetic design. We encourage teams to think creatively and even fantastically about their solar homes. The environment can range from outer space to the arctic, and the inhabitants can be anything from people to butterflies! There are three divisions based on suggested grade ranges. Students in Elementary and Middle school build a solar home using simple circuits, and High School students build solar smart homes, incorporating programmable microcontrollers. Student teams can upload their solar home projects to the Online Solar Challenge and/or participate in an In-Person Solar Challenge. Whether in an Online or In-Person Solar Challenge, student teams demonstrate their knowledge, showcase a functioning solar home, and present their rationale for their design choices. At In-Person events, teams will additionally participate in Instant Challenges to demonstrate teamwork and problem-solving skills to showcase their overall energy knowledge.



Types of **Solar Challenges**

You can participate and prepare for KidWind Challenges in many ways. We recommend starting by exploring the website and trying an Online Solar Challenge. This will help you get a feel for the kind of Solar Home teams have to build and the documentation teams need to provide at a KidWind Challenge Event. Once you are ready, your team can take their Solar Home on the road and participate in one of our KidWind Challenge events. Those top performers from the Online and In-Person Challenges are invited to participate in the annual World KidWind Challenge.

In-Person Challenges

In-Person KidWind Challenges that include the Solar Challenge take place during the school year and are hosted by schools, community centers, and organizations across the country. KidWind Challenges may occur in person, online, or in a hybrid model.

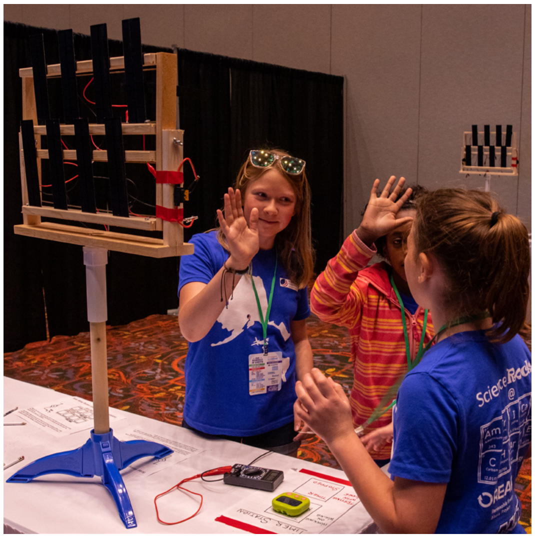
Please check the In-Person Challenge map on our website for details and contact the local organizer to learn more.

Online Solar Challenge

The Online Solar Challenge is open to international submissions, and provides the most accessible approach for any student team, anywhere, to participate. Student teams in grades 4th-12th participate in suggested age-level divisions, working together to create a solar-powered project on the theme of Solar Home. Our online platform allows students to upload their solar home project, design details, reports, presentation, and research to compete with other team submissions. Their solar home will also be shared with the international KidWind online community through the Solar Challenge Gallery on the KidWind website.

In order to participate, each team must have an adult coach whose contact information must be submitted with the project. A coach can be a parent, educator, or mentor and may supervise multiple teams.

Each quarter (designated on our website) submissions will be judged by the KidWind team, and winners will be selected. Winners receive prizes and are invited to participate (optional) in the World KidWind Challenge, a large and prestigious In-Person event, hosted at a conference center in a different state every year. If your team didn't win at an In-Person KidWind Challenge, they have another chance by submitting their work to the **Online Solar Challenge!**



→ ***Please note:*** Not every site will have both a wind and solar challenge. Be sure you check the details of your local event and/or check-in with the event organizer to be sure they have a solar component.

Where should I start?

Take a peek at what projects can look like by exploring the Online Solar Challenge submissions!

This will help you get a feel for the kind of solar homes others are building and the information you will be expected to provide.

How to **Participate**

Participating in the Solar Challenge

Step 1. Find a Coach

An adult coach is required to supervise the project process and sign up teams for In-Person and Online Challenges. During In-Person Challenges, coaches must be present and can supervise no more than 10 students.

Step 2. Assemble a Team

Teams can come in many shapes and sizes, but we've found that teams of 3-5 students are often the most successful!

Step 3. Decide: In-Person or Online?

Visit the **KidWind In-Person Challenge page** to see if there is an event near you, or contact the local organizer.

→ If there is no event near you, you can always participate in the **Online Solar Challenge**.

Step 4. Learn the Rules

Review the requirements outlined on page 9 of this Solar Challenge Guidelines.

Step 5. Learn about Solar

Coaches can help students gain knowledge and experience about solar by utilizing the activities found on the **KidWind Activities page** and in the Resources section of this guidebook. KidWind also has **webinars and instructional videos** to help provide information about solar power and solar design and construction.

Step 6. Gather Supplies

At the minimum, teams will need solar panels and a multimeter. You can use any solar panels you have available or can order them from **KidWind**. Only use solar panels that are 6V or below and produce less than 1.1A.

Tip: Judges are not looking for the most panels used, or the biggest.

Step 7. Setting up A Solar Testing Station

You'll need to set-up a way for teams to test their solar home while they are designing and building to see if everything is working correctly.

The official KidWind Solar Challenge testing rig contains (15) 50W halogen bulbs, outputting 750 Watts. Your solar home must be smaller than 2' width, 2' length, 1' height in order to fit safely in the testing rig with the hot bulbs. The maximum time your project can be under the testing rig, during a Challenge event, is 5 minutes.

Can I Hold an In-Person Solar Challenge?

Many educators ask if they can host an In-Person Solar Challenge. For the most part we say, "yes", but start slow! Start by holding a Solar Challenge in your classroom, then have teams upload projects to the **Online Solar Challenge**.

If that goes well, try to visit an In-Person KidWind Challenge with a Solar Challenge component to see a preview. If you have a local **KidWind (Wind) Challenge**, contact the event organizer and ask them to expand the event to include a Solar Challenge!

And if all else fails, reach out to our team and we'll help you get your own event off the ground. **See our website** for more information about holding your own In-Person KidWind Challenge.

Does KidWind Provide Training?

Before you get into holding your own In-Person Solar Challenge, you may want training to learn more about solar power and how to host a Challenge. KidWind provides fee-based **workshops and free webinars** for those interested in learning more.

Are There KidWind Lessons that Teach About Solar?

KidWind has free solar lessons on our **Activities page**, and doing the **Solar Scavenger** and **Solar Town lesson** with the classroom will get you and your students well prepared to enter into a Solar Challenge. You can also check out the resources page located on page 18.

You can find the designs to build your own set-up in the Solar Testing Rig Diagram on page 24. Keep in mind, coaches are not required to build a KidWind Testing Rig. You can also use incandescent or halogen 50W bulbs in single or multiple desk lamps to make a quick and easy classroom or home testing set-up.

Step 8. Build your solar home!

Use the grade level division guidelines and allowable materials list to help teams design and construct their solar home.

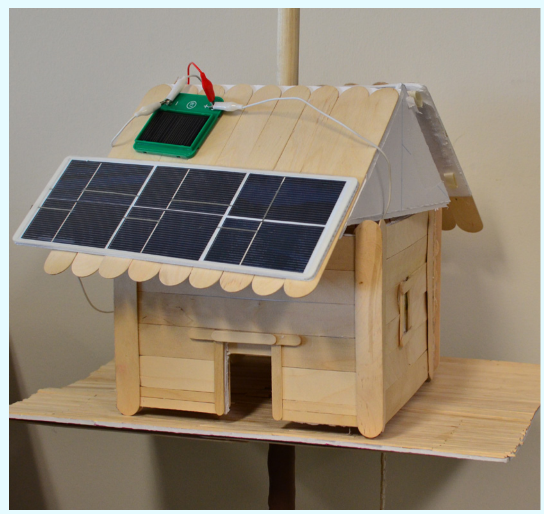
Step 9. Tinker, Tinker, Tinker

Keep making adjustments to improve your design. Don't forget to keep track of any iterations or challenges you encounter during this process and how you addressed them. You'll want to share this documentation with the judges at an event, or upload it to the Online Challenge as an additional resource!

Step 10. COMPETITION TIME!

In-Person Solar Challenge

Carefully pack up the solar home and bring it to an In-Person Solar Challenge. All members of the team and the coach must be present during an event.



At the event, teams will need to present their functioning solar homes to the judges. Be sure you prepare for this and bring the required documentation to help show the judges the design process and inspiration. Some events may also have Instant Challenges and/or a Knowledge Test component. Event winners will be announced at the end of the event!

Solar Online Challenge

Submit the project and required supplementary information (photos, designs, videos, etc.) to the Online Challenge. Keep an eye on the **Online Solar Challenge gallery** to check out your competition. At the end of each quarter, we will select and post the winners!

World **KidWind Challenge**

Each year, we invite top performing teams from In-Person and Online Challenges to compete for variety of awards at the World KidWind Challenge. This large and prestigious in-person event, is held in conjuction with the American Clean Power Association's CLEANPOWER Conference tradeshow and alongside the Collegiate Wind Competition. The location changes each year!

How Do I Get to Worlds?

1. Teams must receive an invitation from World KidWind Challenge organizers in order to attend Worlds.

2. Check the **Worlds page** of the KidWind website for the event location, dates, and details. The coach and team members must attend this 4-day, in-person event. Typically teams arrive on a Sunday morning, compete all day Monday and Tuesday, and then for half the day on Wednesday. Our Awards Cermony is held in the afternoon, and then teams typically head to the airport that night or the next morning.

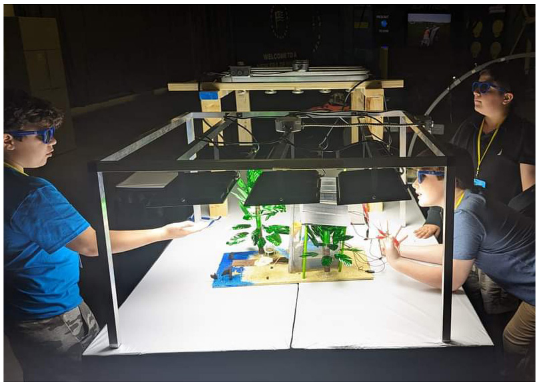
3. The coach must complete the Worlds registration form, which is included in their team's invitation. Each person attending Worlds, including coaches, team members, family, friends, etc. must also complete an Attendee Form and Liability and Media Release Form. Teams will be sent these forms after registering.

4. Book team travel and lodging. We encourage teams to take advantage of KidWind's hotel block that includes discounted hotel rooms near the competition venue. KidWind shares hotel block details in January.

5. Raise money! There's no registration fee or participation cost for team members, coaches, or family joining the team. Coaches and teams will need to provide transportation, as well as room and board for the duration of the event.

6. Attend the event with your team's solar homes and presentations. Teams participate in solar testing, judging sessions, Instant Challenges, and a Quizbowl testing their clean energy knowledge. Meet other coaches and teams and maybe even secure a sponsor for next year.

Solar Challenge **Requirements**

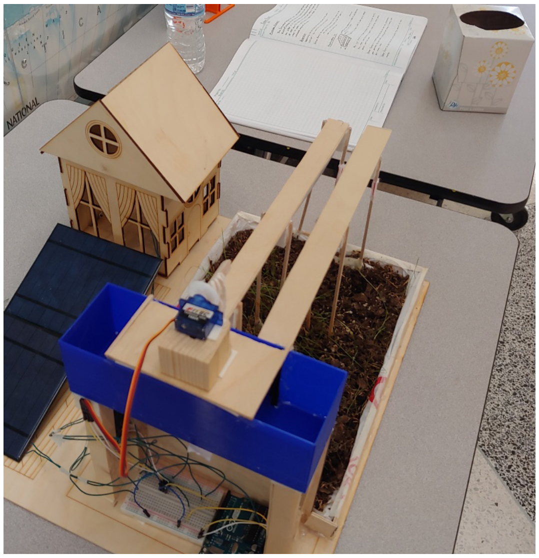


1. Size Limits of Solar Home

The Solar Home and all accessories must fit within a 2' width, 2' length, 1' height space. This provides 4" of safe space between the max height of the solar home and the hot halogen lights.

Tip: Having a bigger device will not boost a team's score.

2. Materials and Material List



Material List

- Each team is required to submit a materials list printed out for events or submitted as a digital file for the Online Challenge. Materials list template on page 21 of guidebook. You may use the template or make your own.

Tip: Resourcefulness and creative use of materials are a factor in the judging rubric.

- The material list is a document for teams to record all materials used in the solar home, the purpose of the material, if the materials are recycled, found, or new, and the costs of materials.
- If the material is a 3D printed part, teams must explain if the file was found, modified, or created. Budget should identify 3D printed parts as new material cost. Material cost = filament price/filament weight x model weight.

Allowable Materials

- Found objects, clay, stable natural materials, fabric, reclaimed or recycled materials, almost anything!
- Arduino, microbit or other programmable microcontrollers for the Solar Smart Home Division (high school).
- Redesigned and reconstructed parts like doll house walls or dollar store solar lamp panels are fine. Repurposing electronic parts like string lights and mechanical toys is acceptable.

Tip: Do not mix panels that have different voltages and/or current into a single circuit

Materials that are **not** allowed

- Lithium batteries of any size or original manufactured solar kits like solar lamps used as is.
- Pre-made manufactured solar battery chargers used as is.
- Original manufactured circuits or circuitry kits used as is (little bits, snap circuits).
- Anything that plugs into a wall 20A 120V AC outlet.
- Unstable materials that are hazardous in any way.

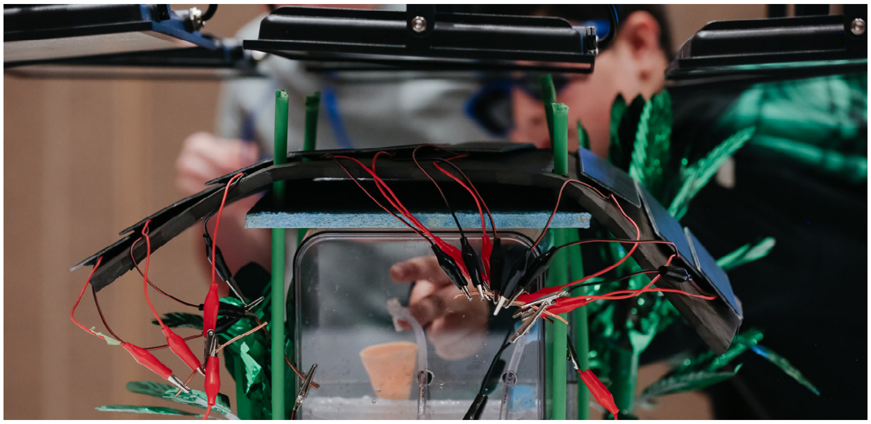
If you have questions, please email us at **help@kidwind.org.**

3. Solar Panels

- Teams can use solar panels from any company and any number of solar panels, as long as the individual panels do not exceed 6V or 1.1A, and the total of all the solar panel configurations do not exceed the maximum voltage 24V, current 2.2A or wattage 48W.
- **All teams must provide Solar Panel Schematics:** In the solar panel schematic, include each solar powered circuit's configuration (parallel/series), and a label to what the terminals connect to. Label each panel's rated voltage and current and each configurations voltage/current total. This Schematic is different from the wiring diagram because it only includes the solar panel arrangement, not the rest of the circuit. For example, if your team has up to three circuits that are powered by solar, they will need to provide three solar panel schematics. Judges will look at and ask questions about the solar panel schematic. **See examples of what your Solar Panel Schematic can look like here**.

Tip: A solar home using the maximum voltage and current will not be scored higher. A solar home with a tiny solar panel that powers something cool will wow the judges more.

- Only one circuit can be without a solar panel, and that exception must have a microcontroller.
- **Solar Home Division (4-5th & 6-8th Grade): Solar panels must power all of the solar home's loads.** The loads can also be powered by using a supercapacitor as power storage, charged by the solar panels.
- **Solar Smart Home Division (9-12th Grade): Solar panels must power at least 2/3rds (66%) of the solar home's circuits.** A microcontroller can use a battery pack (must be sealed lead acid batteries), but the batteries from the microcontroller cannot power more than 1/3rd (33%) of the loads. If you add a solar powered charge controller to power your microcontroller, it must be connected to the microcontroller. Rechargeable batteries cannot be charged separately then inserted into the microcontroller battery pack.



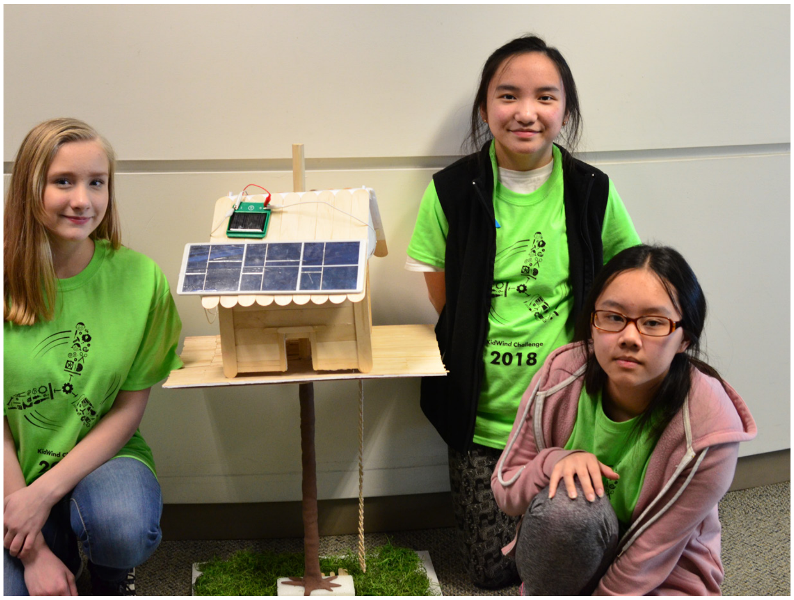
Safety

- Teams will be disqualified if their circuits or materials are deemed unsafe. Contact your local organizers or KidWind if you have questions.
- During an event, teams will have time to test out their solar home repeatedly. There will be time to repair or make very slight improvements to the solar home if necessary.
- If traveling and setting up for an event, avoid and prevent short circuiting by turning the emergency switches to the off position.
- Teams should ensure that moving parts are not sharp or pinching.

Local judges have the final call for safety. If you're not sure about something, contact your local organizers or send us a photo to **help@kidwind.org**

4. Loads and Switches

- **Each circuit must have an "emergency" on/off switch that disconnects the power source from the rest of the circuit.** These emergency switches must be clearly labeled and accessible.
- Teams can use any load to make their solar home interesting. These can include LEDs, incandescent bulbs, motors, doorbells, repurposed switches, relays, etc.
- Pre-manufactured circuits or circuitry kits are not allowed (little bits, snap circuits, etc). Contact us with questions.



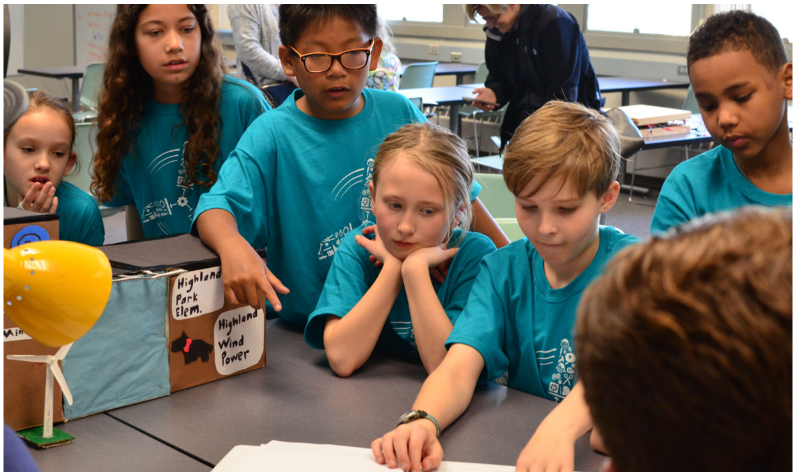
5. Power Storage

- Power storage can be in the form of capacitors, gravity batteries, rechargeable batteries, spring tension or elastic. No Lithium batteries of any kind are permitted.
- Pre-manufactured solar battery chargers are not allowed.
- A solar home is not considered solar powered if teams must manually take charged batteries out of a solar battery charger for placement into a solar home in order to power the loads.
- Teams must label how the solar panels are charging the power storage and how the storage is powering the loads on the device in the wiring diagram.
- Loads can be powered using a supercapacitor (supercap) as power storage, as long as the supercap is charged by the solar panels.

  If a supercapacitor is used, it must be rated at or below a capacitance of 1 Farad and 2.7V. Multiple supercaps can be used, but the max voltage in series cannot exceed 6V. Do not exceed the voltage of the supercap when matching with the voltage output of the solar panel(s). A diode needs to be placed in series with the positive lead of the panel and the positive lead of the supercap.
- A microcontroller of any make can be used as a charge controller, as long as power storage requirements are followed. A microcontroller can use a battery pack (must be sealed lead acid batteries), but the batteries from the microcontroller cannot power more than 1/3rd (33%) of the loads. If you add a solar powered charge controller to power your microcontroller, it must be connected to the microcontroller. Rechargeable batteries cannot be charged separately, then inserted into the microcontroller battery pack.

> If judges deem the power storage to be unsafe, a team's project will be disqualified. Judges will use the wiring diagrams, observation, smell, and careful touch to determine if something is hazardous.

6. Microcontrollers



- The Solar Smart Home Division requires a microcontroller, and any team using a microcontroller will be placed in the Solar Smart Home Division. The suggested grade range is 9th-12th, but ambitious younger teams can give it a try! The judging for Solar Smart Home is more difficult, and uses science, technology, and arts standards for the suggested grade level being judged.
- Any microcontroller can be used.
- There are no limits to how many microcontrollers can be used, as long as the requirements are followed.
- The wiring diagram must label all functions of the microcontroller.
- **A team must provide the programming code printed out for events or submitted as a digital file for online**.
- A microcontroller can be powered by solar panels or use power storage.

- ***Please note:*** Coaches are not required to build a KidWind testing rig. You can also use incandescent or halogen 50W bulbs in single or multiple desk lamps to make a quick and easy classroom or home testing set-up.

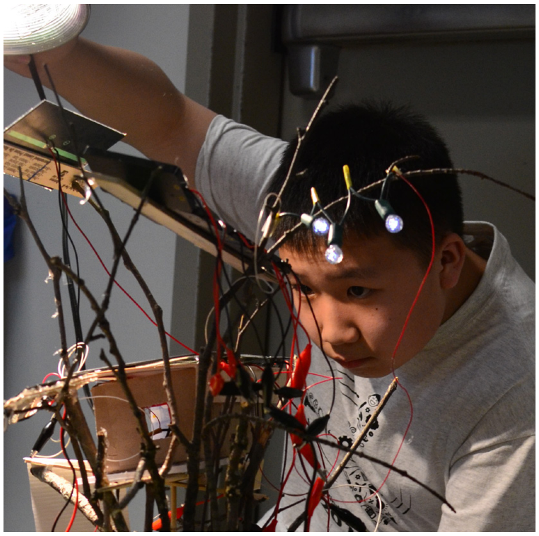
7. Circuits

- **Each circuit must have a wiring diagram**.
- Each circuit must have an “emergency” on/off switch that disconnects the power source from the rest of the circuit.
- Teams can have a maximum of three separate circuits.
- Each circuit must be essential in the functioning of the solar device.
- Only one circuit can be without a solar panel, and that sole circuit must have a microcontroller.

- Keep in mind while constructing your solar home that it may need to be disassembled and reassembled in order to travel to an In-Person Challenge.

8. Wiring Diagram

- **Teams must provide a wiring diagram for each circuit in your project**.
- Each wiring diagram must include a symbols key.
- The wiring diagram must use the symbols for all the electrical parts of a circuit, and all parts clearly labeled.
- Every emergency switch must be clearly labeled in the diagram.
- If using power storage, teams must label how the solar panels are charging the power storage and how the storage is powering the loads on the device.



- Solar Home Elementary 4th-5th Division can create a hand drawn wiring diagram for an event and for the Online Challenge. A photo of the drawing is acceptable. For the the 6-8th and 9-12th grade divisions, teams must either use the wiring diagram template or adapt the template to create their own wiring diagram document. A physical copy of this document must be brought to In-Person Challenges. You may upload a digital file of your wiring diagram to the Online Challenge.
- If the wiring diagram is complicated, there is no need to fit it into a 8.5” x 11” paper size. The team can expand their diagram onto other pages as long as the continuation is clearly labeled.
- The wiring diagram is used in the judges’ scoring process. **See examples of wiring diagrams here.**

Tip: A neat, clearly labeled, easy to read, and well laid out and color coded diagram will score higher.

9. Report

Teams must provide a written report for In-Person Challenges, assembled in the order listed below, and organized in a binder or stapled together. If participating in an Online Challenge, this is all in the online form.

Report includes:

- **Division** (selection box)
- **Grade(s)**
- **Team name**
- **Number of team members not including the coach** (selection box 2-4)
- **Coach name and contact email**
- **School name and location**
- **Cover image of solar home**
- **Size of solar home**
- **Solar home title**

- **Solar Home Summary:** Describe in two sentences or less the general purpose of the solar home, who or what inhabits it, and the environment where it is located. For example: The LoneStar Space Garden provides astronauts in space an Earth-like sanctuary and food garden with plants, waterfalls, insects, and animals, all made possible by solar power.

→ **Solar Home Narrative:** In three paragraphs describe the solar home's purpose, design, and connection.

Purpose: Set the stage by briefly describing the environment and why the selected location was a good place for the solar home. Introduce the inhabitants and their wants and needs. Talk about the solar powered features and how those features address the wants and needs of the inhabitants.

- (1) image of the surrounding environment
- (1) image that shows the inhabitants
- Up to 3 additional images that zoom in on the solar powered features

Design: Tell the origin story of the design idea by explaining why the team used certain materials and technologies. How does the team think the solar home they created is inspired by real world problems? Explain why the team shaped, designed, and organized the solar home in response to its environmental factors. Describe how the needs, health, entertainment, and comfort of the inhabitants were considered.

- 1-3 images that highlights solar home design

Connection: Explain how the team considered the social and cultural connections of the inhabitants when making the solar home. Describe how the solar home is sustainable and how it has a low impact on its environment.

- 1-3 images that focus on how the solar home is green

→ **Teamwork:** Team members describe their roles and how they worked within the team. Each team member lists some part of the process, design, or build of the solar home that they really enjoyed doing.

→ **Solar Panel Schematic(s):** Printed out for In-Person Challenges, submitted as a file for Online Challenges. The solar panel arrangement(s) and the rated voltage and potential current of each panel, and how they add up in the arrangement. It also includes the dimensions of each panel. One schematic per solar circuit. **Find Schematic examples here.**

→ **Wiring Diagram(s):** Printed out for In-Person Challenges, submitted as a file for Online Challenges. Each circuit requires a separate wiring diagram. **Find Wiring Diagram examples here.**

→ **Programming code for Solar Smart Home Division:** Printed out for In-Person Challenges, submitted as a file for Online Challenges.

→ **Materials List:** Printed out for In-Person Challenges, submitted as a file for Online Challenges.

10. Presentation

During an In-Person event, teams will formally present their project to a panel of judges. Coaches are not allowed in the presentation.

Please note that the Online Challenge does not have a formal judging presentation. When judging the Online Challenge, KidWind staff may contact the coach to ask questions.

Depending on the specific event, teams may have anywhere from 8-20 minutes for their presentations. Event organizers will be able to share what teams can expect at their Challenge. It is suggested that presentations take the following shape:

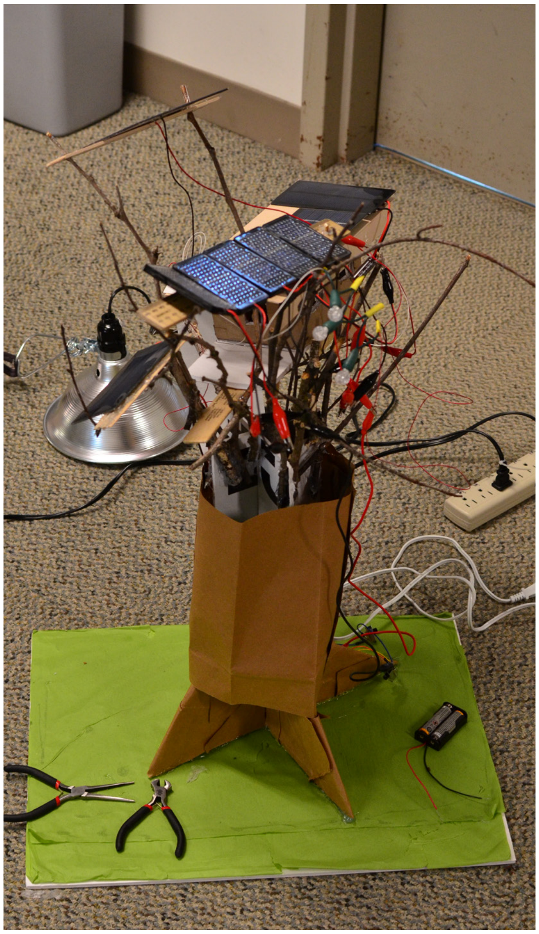
- **Set-Up (1-2 mins):** Team sets up their solar home under the KidWind Solar Challenge testing rig (not testing yet!)
- **Presentation (3-8 mins):** Team provides judges their printed report (2-5 judges). Team introduces themselves, their school, and location. Team states the title of their solar home, the solar home summary (as written in report), and walks judges through the solar home narrative. Team can point to certain aspects of the solar home during the presentation.

Tip: Stick to the time limits! The presentation portion is a big part of the judges score, so teams must make sure everything works beforehand, and team members have their parts down. Teams should know the judges are excited to see the work, and the team should take this opportunity to shine and be proud of what they've achieved!

- **Demonstration (2-5 mins):** Team turns on testing rig, points out the emergency switches, activates them, shows how each circuit performs.
- **Questions (2-5 mins):** Judges will ask the team questions about design, solar panel specs, solar panel orientation and how it connects to the solar home environment, microcontroller specs and programming (if relevant), power storage (if relevant), and the choices the team made in the design process.

Tip: The team should know the solar panel specs inside and out and how to use a multimeter.

Solar **Testing**



The ideal solar testing equipment is the sun which puts out 1000 Watts per meter squared during peak hours under ideal conditions! If the sun isn't cooperating, and a quick test is needed, teams can use a lamp that can handle a 50 to 100 Watt incandescent, halogen, or xenon light bulb. Make sure the safety guard is on to prevent touching the hot bulb. Face the bulb horizontal to the table, so the tip of the bulbs are 1'4" high. A solar home project must fit within the 1' high space limits to provide 4" of safety space from the tip of the hot bulbs. For an event, the best testing equipment is the KidWind Solar Challenge Testing Rig.

At an In-Person KidWind Challenge, organizers should set up a testing rig equivalent to the KidWind Solar Challenge Testing Rig which contains (15) 50W halogen bulbs, outputting 750 Watts. The solar home size limit is 2' width, 2' length, 1' height to fit in the testing rig safely with the hot bulbs. The max time under the testing rig is 5 minutes. The bulbs in the testing rig are 1' 4" from the table, facing perpendicular to the table.

Tip: The position and angle of a solar home's solar panels and how hot they get will affect performance.

Solar testing rigs should be set up in a space with a consistent level of light throughout the day. An example of what to avoid would be rooms with windows to the outside and rooms with fluctuating lighting due to timers or outside controls.

Resources

KidWind Solar Challenge Preparation & Help

KidWind Challenge website

Find someone near you from the **RECharge Academy network**

Take a training (for a fee) or watch the **Solar Energy 101 2024 training recording**

Training document with more resource links

Participate in (free!) monthly **Tinker Time sessions/webinars**

Solar Activities & Curricula

KidWind **Solar lessons**

CREATE **Center for Clean Energy-Advanced Technology Education Lessons**

National Energy Education Development (NEED) Project Lessons: **Solar** and **Science of Energy**

PHET **Electrical and Circuit Simulations**

Solar Schoolhouse **Teaching Solar**

Vernier **Investigating Solar Energy** and **Solar Energy Explorations**

Science Buddies **Solar Activities**

LEGO **Solar Lessons**

We Share **Solar**

NTREG **How to Design and Build a Solar Lunch Box**

SunWind Solar **Small Solar Cars**

Search for more lessons by topic or standard on the **Climate Literacy and Energy Awareness Network (CLEAN) website**

Additional Resources & Videos

Ted Ed **How do solar panels work?**

Energy Kids **Solar**

Wonderopolis **How Do Solar Lights Work?**

SEIA Solar Energy Industries Association **Resources**

KidWind **How to Use a Multimeter**

SparkFun Learn: **Voltage, Current, Resistance, and Ohm's Law, Series and Parallel Circuits, How to Read a Schematic**

Electronics Club **Circuit Diagrams**

TinkerCad **Circuits**

Instructables: Arduino **Introduction to the Arduino World; Internet of Things; Powering Microcontroller Projects**

Instructables: **SuperCaps Let's Learn about Super**

Appendix

Solar Challenge Report Form

All Divisions

Teams must provide a written report for In-Person Challenges, assembled in the order listed, and organized in a binder or stapled together. If participating in an Online Challenge, this is all in the online form.

Solar Home Narrative

Solar home title

Solar home summary: Describe in two sentences or less what the solar home is (that could be its name, materials, shape, general purpose) what inhabits it, the environment it's in, and its general purpose. For example: The LoneStar Space Garden provides astronauts in space an Earth-like sanctuary and food garden with plants, waterfalls, insects, and animals, all made possible by solar power.

Purpose (1 paragraph): Set the stage by briefly describing the environment and why the selected environment was a good place for the solar home. Introduce the inhabitants and their wants and needs. Talk about the solar powered features and how those features address the wants and needs of the inhabitants.

- 1 image of the surrounding environment
- 1 image that shows the inhabitants
- 1-3 images that zoom in on the solar powered features

Design (1 paragraph): Tell the origin story of the design idea by explaining why the team used certain materials and technologies. How does the team think the solar home they created is inspired by real world problems? Explain why the team shaped, designed, and organized the solar home in response to its environmental factors. Describe how the needs, health, entertainment, and comfort of the inhabitants were considered.

- 1-3 images that highlight the solar home design

Connection (1 paragraph:) Explain how the team considered the social and cultural connections of the inhabitants when making the solar home. Describe how the solar home is "green," and how it has a low impact on its environment.

- 1-3 images that focus on how the solar home is "green," optional photo of how the design considers social and cultural connections

Teamwork (1 paragraph:): Team members describe their roles and how they worked within the team. Each team member lists some part of the process, design, or build of the solar home that they really enjoyed doing.

General Information

Division:
- ○ Elementary Solar Home
- ○ Middle School Solar Home
- ○ Middle School Solar Smart Home
- ● High School Solar Smart Home

Grade of team members:

Number of team members not including the coach:

Team Name:

Coach Name:

Coach Email:

Coach Name:

Coach Email:

Size of solar home:
The Solar Home and all accessories must fit within a 2' width, 2' length, 1' height space.

Materials List

Material	How was the material used in the build?	Is the material recycled, found, or purchased?	If purchased, how much did it cost? If free, put a zero
		TOTAL:	

Wiring Diagram

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

Team Name:

School Name:

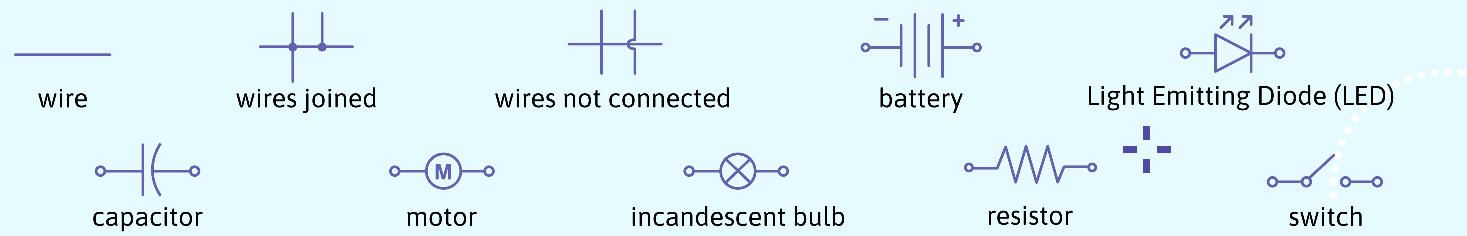
Circuit #: /

Draw your diagram in the box below:

See examples here.

Reminder: All lines in a wiring 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

Solar Panel Schematic Template

In the space below, draw your solar panel configuration and provide details about each solar panel.

Be sure to:

1. Draw each solar powered circuit's arrangement (parallel/series) and the terminal it is connected to.
2. Label each panel's rated voltage and current and provide the total voltage and current for that circuit.

Team Name:

School Name:

Circuit #: /

Draw your schematic in the space below:

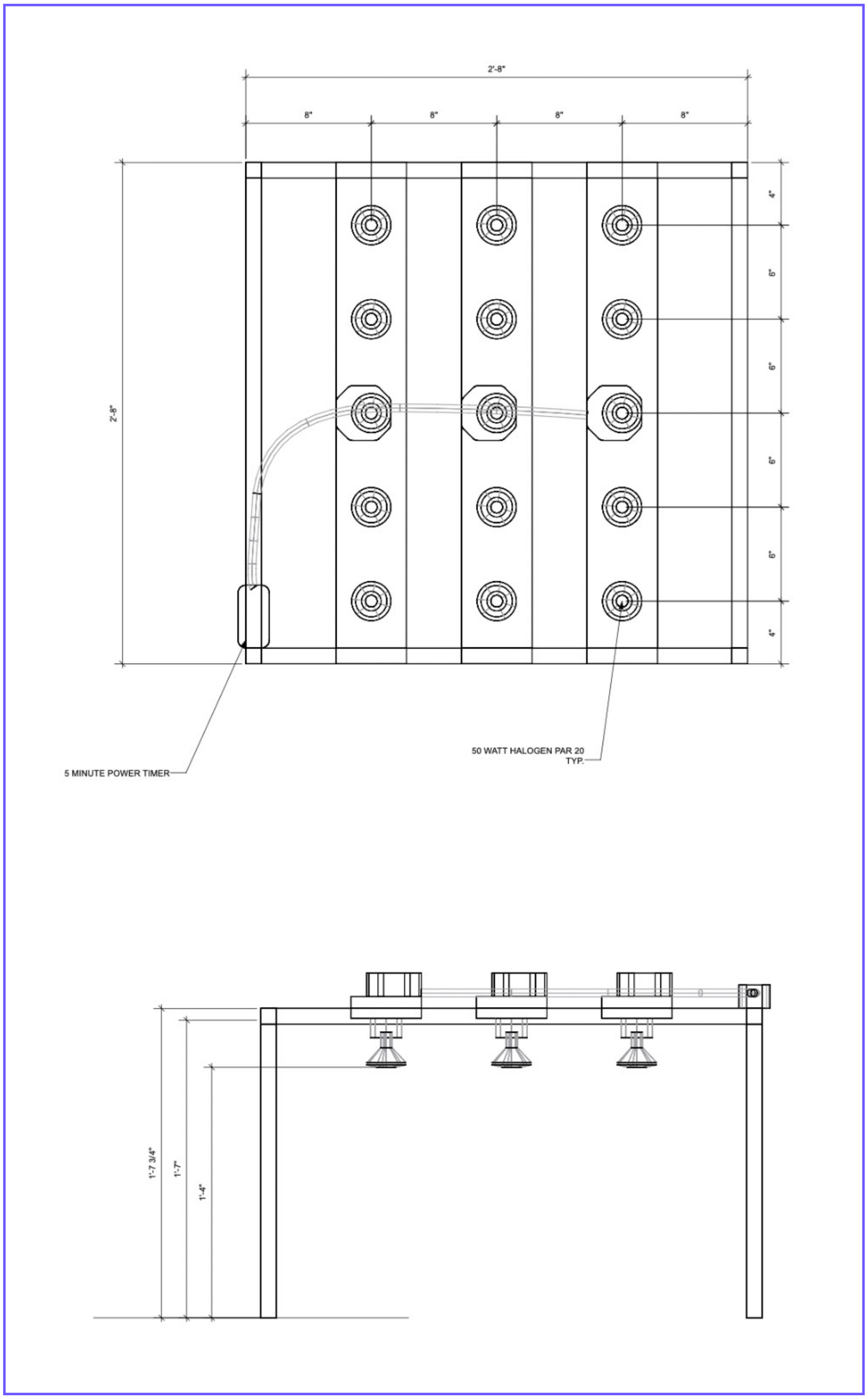
See examples here.

Did you:

- ☐ Provide one schematic per solar circuit
- ☐ Draw the solar panel arrangement(s)
- ☐ Label the rated voltage of each panel
- ☐ Label potential current of each panel
- ☐ Provide the total voltage and current of the circuit

KidWind Solar Testing Rig Details

- → **From table to tip of bulb 1' 4"**
- → **Solar Home max dimensions 1' Height, 2' Width, 2' Length**
- → **(15) 50W halogen bulbs link to specs producing an estimated output of more than 750 Watts**
- → **(3) 5-light vanity units link to specs**
- → **5 Minute timer**



10 Big Questions **About Energy**

Here are some questions to get you thinking about clean 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!

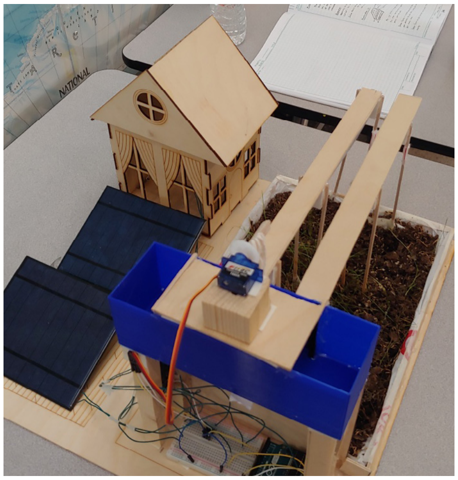
While these broad and expansive questions can be explored by students across the grades, some subquestions may be geared to younger or older students. Coaches can help steer students to the questions most appropriate for their grade-level.

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

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

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 clean 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?

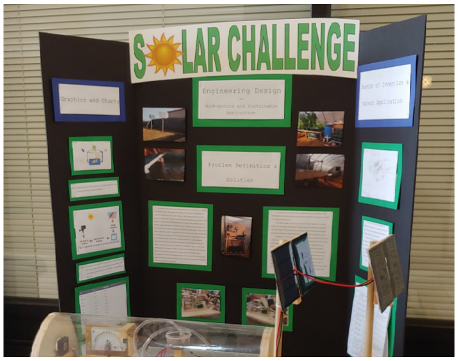


2. How do we measure and quantify electricity?

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?

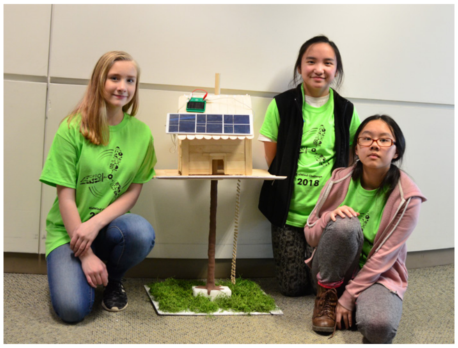
3. What is climate change and how can clean energy impact this phenomenon?

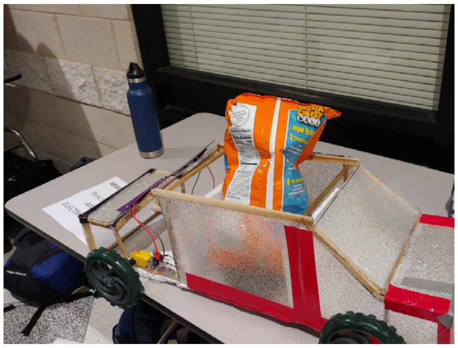
What is climate change and who does it impact? What are the environmental benefits of generating electricity using wind or solar power? What are some of the tradeoffs? What challenges might we face in generating over 50% of electricity from clean resources in the U.S.? How does efficiency and conservation 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?





5. How does weather and geography impact clean 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 clean 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 clean energy?

How do we financially subsidize clean 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 clean energy powered future look like?

Is it realistic to think we can power the grid with 100% clean 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 clean energy careers?

Developing and installing clean 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 clean 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.*