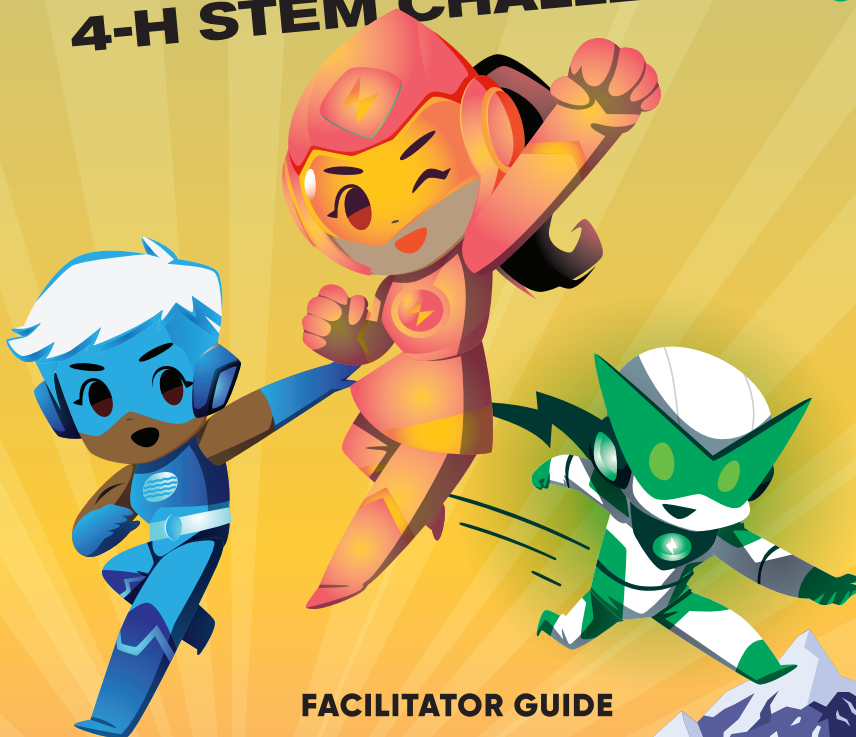


POWER PROTECTORS

4-H STEM CHALLENGE



FACILITATOR GUIDE





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KIT MATERIALS

The following items are included in this kit to serve up to six youth. Additional printable materials, along with a Spanish edition of the facilitator guide, are available for download online at 4-H.org/programs/stem-challenge

- 1 - Power Protectors Storage Bag
- 1 - Facilitator Guidebook
- 1 - Deck of Watts Up Cards (24)
- 6 - Superhero Hideout Blueprints
- 1 - Energy Island Adventure Board Game
 - › Includes game board, instruction sheet, deck of cards (96), 18 energy tokens (6 solar, 6 wind, 6 hydro)
- 1 - Amped Up Engineering Supply Pack
 - › Includes, small screwdriver to be used as a reamer, 12 - 6" dowel rods, and 6 round cardboard pieces
- 6 - Amped Up Engineering Design Sheets
 - › Includes 2 solar, 2 wind, 2 hydro
- 12 - Dry erase markers with attached erasers
- 3 - Career Posters

CREDITS

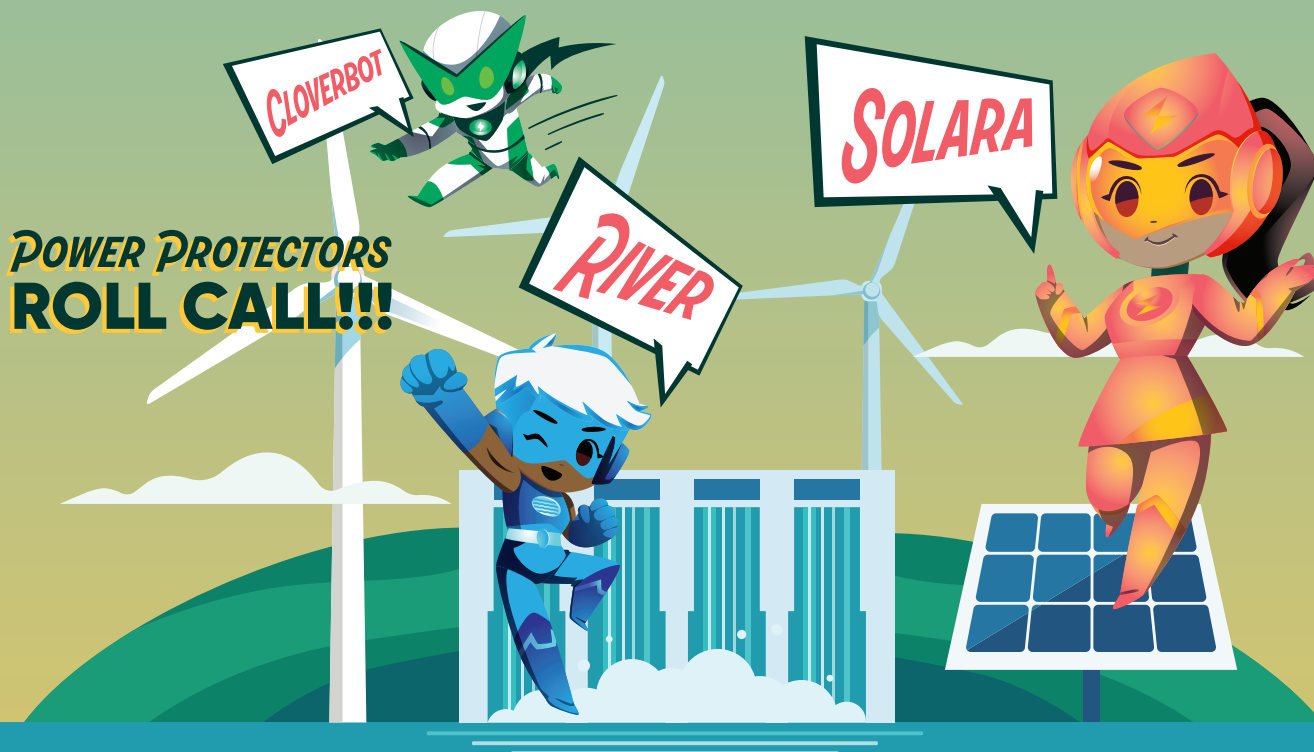
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A big thank you to all the groups of youth, 4-H educators and K-12 school teachers for testing and piloting this year's challenge!

LeRoy Elementary School - LeRoy, Illinois
Home Spun 4-H Club - Bloomington, Illinois
Unity Community Center - Normal, Illinois
West Virginia University Extension, STEM Working Group
West Virginia University, Jackson's Mill 2023
Winter Homeschool Day
Welch Elementary School - Welch, West Virginia
Warm Springs Middle School - Berkeley Springs, West Virginia
Entheos Academy - Kearns, Utah
Salt Lake County 4-H STEM Team - South Jordan, Utah
Utah 4-H STEM Ambassadors - Logan, Utah
Bradshaw Elementary School - Bradshaw, West Virginia
Mount View Middle School - Welch, West Virginia
River View High School - Bradshaw, West Virginia





INTRODUCTION

4-H is the largest youth development organization in the United States, serving nearly six million youth each year. Our philosophy is to provide young people with fun and engaging educational experiences that give them an opportunity to learn and develop important life skills including decision making, communication and perseverance. Our goal is to help youth thrive by providing programs that allow them the opportunity to find the spark that ignites a passion to learn about and stay engaged in STEM. Learn more at [4-H.org](https://4-h.org).

In 2023, National 4-H Council partnered with Cornell University, the University of Illinois, Utah State University and West Virginia University to create the Power Protectors STEM challenge kit.

This kit is ideal for youth ages 8-14 years to spark an interest in STEM and inspire real-world actions. Power Protectors focuses on renewable energy providing youth the fundamental knowledge of sustainable power sources, the energy people use on a daily basis and the importance of using energy wisely.

This guide contains everything for facilitating three renewable energy related activities with no prior STEM experience needed. Activities have been designed with simplicity and adaptability in mind so that anyone – from teachers to teen leaders to parents – can facilitate them. There is a logical progression to the activities presented in the challenge, but each activity can be conducted independently or in any order. Each activity includes a set of opening and closing reflective questions to enhance the learning and fun of the experience.

FACILITATOR PREPARATION

This section provides the background needed to comfortably present and teach the STEM topics covered in this year's Power Protectors 4-H STEM Challenge kit. Let's get started!

Facilitator Checklist

- Visit 4-H.org/programs/stem-challenge information and resources videos for this year's challenge.
- Select kit activities that best fit your group, time and space.
- Review the vocabulary, materials and full instructions for each of the activities you choose.
- Review the basics of the engineering design process found on page 22.
- Gather the supplies needed to complete the activities.

Skills Inventory

STEM learning skills are the skills youth need to be successful when they explore and engage in science, math and engineering experiences and activities. These skills also align with important life skills taught within 4-H. Key STEM skills the Power Protectors activities help youth to develop include:

- **Creativity:** The act of using imagination to bring original ideas to life. Applying creative approaches to STEM-based challenges helps youth express thoughts and feelings, improve problem solving skills and be open minded to unlimited possibilities.
- **Critical Thinking:** Analyzing, evaluating, reflecting and processing information to propose solutions to solve problems. This process helps youth develop into independent, critical thinkers.
- **Collaboration:** Teamwork and working together in groups. Collaboration teaches youth how to identify strengths of team members and how to work together to efficiently complete a task.
- **Decision Making:** Choosing between possible solutions to a problem. Making decisions helps youth investigate their ideas, develop critical thinking and learn how to compromise with others.
- **Engineering Design Process:** Using a cycle of asking questions, imagining solutions, formulating a plan, creating and improving design ideas to solve a problem. Through each step, youth get closer to finding a solution to the problem, while using STEM skills in the process.
- **Inquiry Skills:** Solving problems by asking questions, proposing ideas and testing solutions. This puts youth in the driver's seat to their own learning.
- **Problem Solving:** Creating and finding solutions to effectively solve a problem. This requires youth to use the information they have and apply a problem solving process (such as the Engineering Design Process) to reach a solution.
- **Real-World Application:** Youth learn and develop skills, then apply these to solve real-world problems. This helps youth connect STEM-based learning skills to real life scenarios, careers and workplace applications.

Planning Delivery

Power Protectors is adaptable to a wide range of space, time and technology constraints. Each of the three activities are “unplugged” and do not require technology to deliver them. Superhero Hideout, Amped Up Engineering and Energy Island Adventure can be enjoyed separately and in any sequence to fit any out-of-school learning environment, classroom or family time.

Facilitation Tips

Encourage thinking, sharing and making connections during these activities. A great strategy to do this is to use the K-W-L (Know-Want-Learned) approach. To introduce new topics, anchor youth in their current knowledge, stimulate thought and track learning, focus questions around what youth know, what they want to learn and what they have learned. Ask K-W-L questions directly to youth, have them write answers down independently or create a graffiti wall with a designated spot for each question. Each activity has getting started and reflection K-W-L questions to use to direct discussion.

Career Connections

Included in the Power Protectors kit are three Career Connection Posters. Sponsored by Nestlé in the U.S., each poster has been designed for use with either Superhero Hideout, Amped Up Engineering or Energy Island Adventure and contains information on specific sustainability and renewable energy careers and relevant energy information.



ACTIVITY OVERVIEWS

Power Level: CRITICAL. Through decades of neglect and waste, Energy Island is in danger of becoming unplugged forever. Now it's in the hands of the next generation – The Power Protectors – to bring back a sustainable balance by completing three engaging activities—using cooperation, determination and the **POWER** of reusable energy.

Superhero Hideout

Learn the awesome aspects of sustainable power to assess your own energy use and design an electrifying Power Protectors hideout.

Activity Time:

- 60 minutes
 - › Intro: 20 mins
 - › Activity: 30 mins
 - › Reflection: 10 mins

Additional Materials Not Included:

- Pens/pencils
- Paper

Energy Island Adventure

Work together as a SUPER team with a common goal—help endangered Energy Island move from its unsustainable carbon-based energy use to renewable solar, wind and hydro power. Play – and WIN – together as The Power Protectors.

Activity Time:

- 60 minutes
 - › Intro: 5 mins
 - › Activity: 30–45 mins
 - › Reflection: 10 mins

Amped Up Engineering

Choose, design and build a model of a sustainable energy source to help Energy Island survive and thrive.

Activity Time:

- 60 minutes
 - › Intro: 5 mins
 - › Activity: 45 mins
 - › Reflection: 10 mins

Additional Materials Not Included:

- Assorted recyclable materials, including cardboard, plastic water bottles, soft drink or milk bottles, plastic lids of different sizes, tin foil, disposable aluminum pans, etc.
- Masking tape and/or low-temperature glue gun
- Scissors or tin snips
- Box fan or small fan (with various speeds preferred)
- Flashlight (ideally with strong focused beam)
- Paper and pencil or permanent markers

SUPERHERO HIDEOUT!

Power your superhero gadgets and protect the environment. Decide how to use electricity responsibly in your Superhero Hideout!

Goals, Objectives and Outcomes

By the end of the lesson, youth will be able to:

- Explain what energy is and how it is used.
- Identify how much electricity a variety of household appliances use.
- Name three things someone can do to reduce their electricity use.
- Design a Superhero Hideout that maximizes electricity use.

• Activity Time (60 minutes)

- Intro: 20 minutes
- Activity: 30 minutes
- Reflection: 10 minutes



IMPORTANT VOCABULARY

- **Electricity:** A form of energy resulting from the flow of an electric charge.
- **Energy:** The ability to do work. Energy comes in two forms: potential (stored) and kinetic (movable).
- **Energy efficiency:** Using technology that requires less energy to do the same work. For example, using a LED light bulb that requires less energy instead of an incandescent light bulb to produce the same amount of light.
- **Engineer:** A person who uses scientific knowledge and training to design, build or operate engines, machines, systems or structures.
- **Engineering Design Process:** A series of steps that engineers use to create solutions to a problem or challenge.
- **Kilowatts:** A measure of 1,000 watts of electrical power.
- **Kilowatt hour:** A measure of electrical energy.
- **Non-renewable energy:** Energy from a natural resource or source of energy that is not capable of being replenished such as oil or coal.
- **Renewable energy:** Energy from a source that is not depleted when used, such as wind or solar power.
- **Watt:** The unit of power used to calculate the rate of energy transfer.

Materials

Included in the kit:

- Deck of Watts Up Cards
- Superhero Hideout Blueprint (one per group)
- Dry erase markers (one per group)

Not Included in the kit:

- Pens/pencils
- Paper



Activity Guidelines

Part 1: *WATTS UP?*

Get Energized

In this warm-up activity youth will learn what energy is, where it comes from and the amount of energy a variety of gadgets and household appliances need to work.

To get started, ask some questions:

- When you hear the term **energy**, what do you think of?
- When you hear the term electricity, what do you think of?
- What is the difference between energy and electricity?
- What are some items that use energy that you can see or think of right now?
- What are some items that use electricity in your home?
- How do you think energy is produced?

Energy comes from two main sources, renewable and non-renewable. **Renewable energy** comes from a source that is not depleted when it's used. Examples include solar, wind and hydropower. **Non-renewable energy** comes from a natural resource that is unable to be replenished once it's used. Examples include oil and coal, both of which come from within the earth.

Non-renewable energy has worked in the past to help people get the energy they need, but these sources are limited and have the potential to harm the environment. This is why it's so important to create and use renewable sources of energy that provide a safer, cleaner means of energy for the health of people and the planet.

Whatever type of energy we consume, it's important to use it wisely and not waste it. To learn more about efficient energy use, youth will explore how much electricity everyday appliances and electronics use.

Sort it Out

Randomly hand out Watts Up cards with the image and gadget name facing up. **Do not have youth look at the side of the cards with the Watts Up score at this point.** If there are not enough cards to go around, split the youth into groups and have them share. ONLY looking at the side of the card with the gadgets, ask the following:

- What do you notice about the items pictured on the front of the cards?
- Of the items on the cards, which would you guess uses the most energy and why?
- Which items would use the least energy and why?

Have youth organize cards in order of the gadgets that use the least to the most amount of **Watts**. They can arrange the cards on a table or hold the cards up for others to see. Activity variations include:

- Challenge the group to sort the cards while remaining silent.
- Have the group arrange themselves in a line from least to most energy used.
- Brainstorm and guess how much energy the gadgets use. Sort the cards into three categories. High (10-7 points), Medium (6-4 points) and Low (3-0 points) watts used.

Next, have youth flip over the cards so the **Watts Up** side is facing up. Explain that each object on the cards has the following:

- A **Watts Up** score. This score ranges from 0 to 10. A score of 0 means the item doesn't require electricity whereas a 10 means it needs a large amount of electricity to work.
- An Estimated Yearly Energy Cost. This is an average of how much money this gadget costs to use over the span of one year.
- A kWh (**kilowatt hour**) number. This is a measure of the electrical energy the object uses per hour. **Kilowatts** help us keep track of how much electricity we use in places like homes, schools and offices.

Wrap Up Reflection:

- Did you guess the correct order of which appliances used the least amount to the most amount of energy? Did any of the usage amounts surprise you?
- How did you decide which appliances use the least amount of energy and which use the most?
- What can you look for in an appliance to predict how much energy it might use?
- Now that you have examined everyday items that use energy, what are three things you can do to reduce your energy use?



FACILITATOR TIP

Have youth give examples of energy use from their everyday lives.

Part 2: *DESIGN A SUPERHERO HIDEOUT*

Energy Island is in crisis! All power sources are at capacity with the threat of total blackout looming behind every switch and plug. Help the Power Protectors design a Superhero Hideout to use power energy efficiently and save Energy Island from being in the dark forever.

In the Amped Up Engineering activity, youth will have the opportunity to design and create a renewable energy source to power their hideout.

Watt's Your Superhero Persona?

Introduce the activity using the following questions:

- What does the word superhero mean to you?
- What are examples of special powers that superheroes have? How are they used to help others?
- How could superheroes use their special powers to solve energy issues? Examples of this include:
 - › Solara turns energy from the sun into oxygen to help people breathe.
 - › Cloverbot helps people replace old appliances with new, energy efficient ones.

Allow time for youth to create a superhero persona including a name and special powers they possess. Have the group explain the powers they chose and how they could help solve energy issues. Provide an opportunity for participants to share their newly created personas with the entire group, in smaller groups or in pairs.

Power on Energy Island

Using their newly created superhero persona to guide decision making, youth will design a Superhero Hideout to learn more about everyday energy use.





FACILITATOR TIP

Use the Energy Island Adventure board game as a visual.

Superhero Hideout: Design Time!

Before beginning, have youth think about and share answers to the following questions:

- What would be helpful for you to know about Energy Island that will help determine where your hideout will be located?
- Energy Island has a temperate climate with hot summers, cold winters and some rainfall/snow throughout the year. How does the weather affect your choice of gadgets?
- Will your hideout be near the river, on a mountaintop, underground or somewhere else? Why would you choose this location?
- How will the location affect what electrical gadgets you use in your hideout?

Hand each group/pair the Design Your Superhero Hideout blueprint. Explain that before they can help save Energy Island, every superhero needs a hideout to live in and a place to make their super plans. Using the blueprint, it is each group's challenge to design their Superhero Hideout. Youth only have **30 points** of Watts Up objects they can include in their hideout.

To complete the activity, youth need to:

- Decide how many rooms their hideout needs.
- Give each room a name that describes what it's used for or a fun super name!
- Examine the Watts Up Gadgets list and select which ones they need in the hideout.
- Design their hideout by drawing or listing the gadgets that belong in each room.
- Calculate the gadget points for each room, then add all room scores together to get the Hideout Total Energy Score.

Youth are encouraged to use steps from the **Engineering Design Process (EDP)**. The EDP is a problem solving process that helps engineers to create and test new ideas. While engineers do their work, they encounter a variety of limitations including: the time they have to complete their tasks, the supplies and funding available and the knowledge they have about the current problem they are trying to solve. Using the EDP will help youth design their hideout while working within the specifications of the activity.

Have youth use the following EDP steps to guide their hideout creation:

Ask - What is the task you have been given to do or the problem you have been asked to solve? What are the limitations to solving this challenge? Write this down in your own words or tell it to another person.

Imagine - Brainstorm all of your ideas: What rooms do you need in your hideout? How could each room be used? What are all the gadgets you would like to have in each room of your hideout? How will you use each gadget to help you save Energy Island?

Plan - Decide how many rooms your hideout will have, the names of the rooms and which gadgets you'll use. Remember you only have **30 points** of energy to use.

Create - Bring your blueprint to life by drawing and writing on it. Label the rooms with names, describe each room's purpose and which gadgets will be in the rooms.

Test - Now that you have a hideout design, does it look the way you want it to? What changes could you make to improve your blueprint? What gadgets do you have that you might not need? Are there alternate gadgets you could use to achieve the same goal that use less energy?

Improve - Show your blueprint to others and ask for their feedback. Make your blueprint better by adding new ideas you have or ideas others shared with you.



FACILITATOR TIP

Post the steps of the Engineering Design Process (EDP) in an area where all youth have access. Large wall post-its or handouts with the EDP steps and questions to consider for each step are recommended.

As youth are working, ask these reflection questions:

- What is necessary for you to survive and thrive, keeping your 30 point power supply in mind?
- How will you decide what gadgets to keep and what not to include in your hideout?
- How can you get the most work done in your hideout by using the least amount of electricity? For example, choosing one item that can perform multiple tasks.

Share

Once finished, have each small group/individual share their hideout design with another person or the entire group. Encourage the group to explain their process of choosing gadgets and their placement in different rooms.

Reflection

Guide youth through a discussion to reflect on and make meaning of their experience.

What is something new you learned by doing this activity?

What surprised you about the energy use of various gadgets?

How can you improve electricity use in your home, school or community?

More to Explore

If youth want to dive in deeper on this design adventure, consider the following activities:

- Invite the groups/individuals to combine their hideout ideas into one collaborative design.
- Have youth customize their hideout even further by adding gadgets or appliances to their hideout. Use this Watts Up point scale to keep track of energy usage. Visit the U.S. Energy Information Administration (EIA) website for help.

Appliance Electricity Use (kWh/yr)	Score
9,500 or higher	10
8250 - 9499	9
7000 - 8249	8
5750 - 6999	7
4500 - 5749	6
3,250 - 4499	5
2000 - 3249	4
1,000 - 1,999	3
200 - 999	2
1 - 199	1

Educational Standards – NGSS

- 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

AMPED UP

ENGINEERING



Get ready for an epic Engineering challenge! Design and build a renewable power source to energize your Superhero Hideout and help save Energy Island.

Goals, Objectives and Outcomes

By the end of the lesson, youth will be able to:

- Explain the differences between renewable and non-renewable energy.
- Name and define three renewable sources of energy.
- Design and build a prototype of solar, wind or hydro power source.

Activity Time (60 minutes)

- Intro: 5 minutes
- Activity: 45 minutes
- Reflection: 10 minutes

Materials

Included in kit:

- Dry erase markers
- Phillips screwdriver
- 6 Round cardboard pieces
- 6 Super Support Sheets (2 solar, 2 wind and 2 hydro)
- 12 Wooden dowel rods

Not included in kit:

- Assorted recyclable materials, including cardboard, plastic water bottles, soft drink or milk bottles, plastic lids of different sizes, tin foil, disposable aluminum pans, etc.
- Masking tape and/or low-temperature glue gun
- Scissors or tin snips
- Box fan or small fan (with various speeds preferred)
- Flashlight (ideally with strong focused beam)
- Paper and pencil or permanent markers



IMPORTANT VOCABULARY

- **Electricity:** A form of energy resulting from the flow of an electric charge.
- **Energy:** The ability to do work. Energy comes in two forms: potential (stored) and kinetic (movable).
- **Energy generator:** A machine that converts one form of energy into another.
- **Engineer:** A person who uses scientific knowledge and training to design, build or operate engines, machines, systems or structures.
- **Engineering Design Process:** A series of steps that engineers use to create solutions to a problem or challenge.
- **Hydroelectric energy:** A form of renewable energy that uses the movement of water to generate electricity.
- **Non-renewable energy:** Energy from a natural resource or source of energy that is not capable of being replenished such as oil or coal.
- **Renewable energy:** Energy from a source that is not depleted when used, such as wind or solar power.
- **Solar energy:** A form of renewable energy that uses power from the sun's rays to
- **Turbine:** A device that produces energy by using a fast moving stream of water, air or steam to move a rotor or wheel.
- **Prototype:** A model or sample created to test an idea or concept.
- **Wind energy:** A form of renewable energy that uses the movement of wind to generate electricity.

Activity Guidelines

Get Energized

In this warm up activity, youth will learn the difference between renewable and non-renewable energy and three types of renewable energy sources.

To get started, ask some questions:

- When you hear the term **energy**, what do you think of?
- When you hear the term **electricity**, what do you think of?
- What is the difference between energy and electricity?
- What are some items that use energy that you can see or think of right now?
- What are some things that use electricity in your home?
- How do you think energy is produced?

Energy comes from two main sources, renewables and non-renewables. **Renewable energy** comes from a source that is not depleted when it's used. Examples include solar, wind and hydropower. **Non-renewable energy** is energy that comes from a natural resource that is unable to be replenished once it's used. Examples include oil and coal, both of which come from within the earth.

Non-renewable energy has worked well to help people get the energy they need but these sources are limited and have the potential to harm the environment. This is why it's so important to create and use renewable sources of energy that provide a safer, cleaner means of energy for the health of people and the planet. Whatever type of energy we use, it's important for us to use it wisely and not waste it.



FACILITATOR TIP

Use the Energy Island Adventure game board as a visual.

In order to help Energy Island rely on sustainable energy sources for power, youth will use a renewable source of energy to power their own Superhero Hideout. The three renewable sources available on Energy Island are:

- **Hydroelectric energy** – A form of renewable energy that uses the movement of water to generate electricity.
- **Solar energy** – A form of renewable energy that uses power from the sun's rays to generate electricity.
- **Wind energy** – A form of renewable energy that uses the movement of wind to generate electricity.

Each of these renewable sources requires some type of system to help generate electricity that can be used to power homes, buildings and Superhero Hideouts!

Prototype Design

Design and build a solar thermal, wind or hydro **prototype** to power your Superhero Hideout! Choose one of Energy Island's three available renewable sources: sun, wind or water to efficiently energize your hideout and help save Energy Island.

For more information about creating a hideout, see the Superhero Hideout activity in this Power Protectors kit.

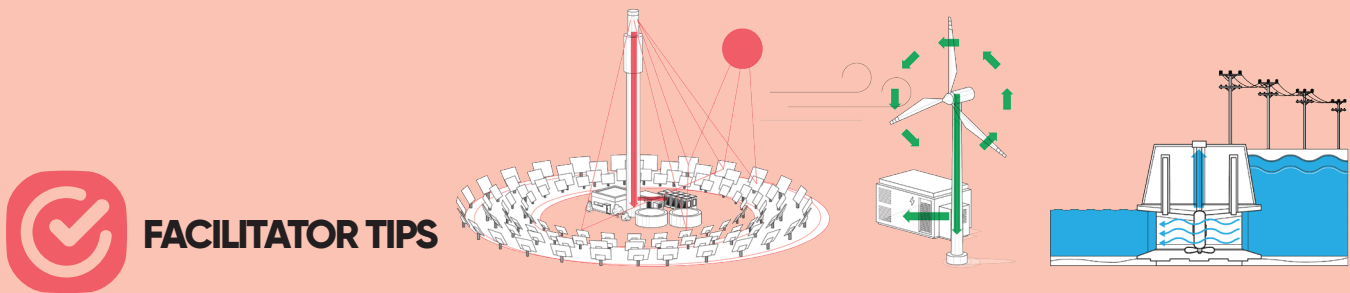
To get started, ask some questions:

- What would be helpful to know about Energy Island to help you choose a location for your own superhero hideout?
- Of the three available renewable sources, what type would you use to power your superhero hideout if it was located in the following locations on Energy Island:
 - › Near the river?
 - › On top of a mountain?
 - › In the desert?
 - › Underground?
- Why would you use that type of power source in that location?

To help youth decide which prototype to create, share the information from each of the three Super Support Sheet handouts.

Have youth work in small groups or as individuals. Each needs to:

- Decide where on the island they want to have their hideout and describe the location.
- Decide which prototype to create: a Super Solar Reflector and Tower, Wind Turbine or Hydro Turbine.
- Receive a copy of a Super Support Sheet handout and a set of dry erase markers.
- Begin to design, build, test and improve their model.



FACILITATOR TIPS

- If needed, make copies of the front and back of Super Support Sheets for each youth.
- Use the screwdriver to make openings large enough for the dowel rods to fit through the selected construction materials.
- For building and testing the Solar Reflector and Receiver Tower:
 - › Create the mirrors and receiver tower using wooden dowels, aluminum foil or other supplies.
 - › Each of the mirrors should reflect as much light onto the receiver as possible.
 - › Use a flashlight to mimic sunlight. A light with a finer focal point and stronger beam is recommended.
 - › Use a fan with a variety of wind speeds to test the sturdiness of the tower.
- For building and testing the Wind Model:
 - › Create the turbine using wooden dowels, rods or other supplies.
 - › Use a fan with a variety of wind speeds to test the sturdiness of the tower. Direct the wind from different directions, distances and angles.
- For building and testing the Hydro Model:
 - › Create the turbine using wooden dowels, rods or other supplies.
 - › For testing, to save time and mess, a fan can be used instead of water.
 - › Use a fan with a variety of wind speeds to test the sturdiness of the tower. Air should flow from one consistent direction only.

Youth should use the steps of the Engineering Design Process to make their prototype. In the real world, engineers use this process to create solutions to solve problems and create new and improved ways to do things. While engineers do their work, they have to deal with a variety of limitations including: the time they have to complete their tasks, the supplies and funding available and the knowledge they have about the current problem they are trying to solve.



FACILITATOR TIP

Post the steps of the Engineering Design Process (EDP) in an area where all youth have access. Large wall post-its or handouts with the EDP steps and questions to consider are recommended.

Ask – What is the task I have been given to do or the problem I have been asked to solve? What are the limitations to solving this challenge? Write this down in your own words or share it with someone else.

Imagine – Brainstorm all of your ideas: What are the essential components, or parts, of your prototype? Which of the building supplies you have would be best to create each part of the prototype? Write down your ideas.

Plan – Choose one or two of your best ideas. Draw initial plans for what the prototype could look like and what supplies you might use.

Create – Use the kit supplies and other materials to build a prototype design.

Test – Test your prototype in as many different ways as you can think of. Take notes about what's working well and what's not.

Improve – Make changes to your design to make it work better. It may take several versions of the design to get it right! Continue the process of redesigning and retesting until your model works smoothly or you run out of time.

Share

Once finished, have each small group/individual share their prototype with the entire group or one-on-one. Encourage youth to explain their design, any challenges they faced and what they did to overcome the challenges.

Reflection

To wrap up the activity, ask youth to answer the following questions:

- What challenges did you face as you built a renewable energy prototype?
- What change(s) did you make to make your prototype work better? How do you know those changes had an impact?
- How could your prototype help Energy Island use only renewable energy as a power source?
- What have you learned about yourself as you were doing this activity?

More to Explore

If youth want to dive in deeper on this design adventure, consider the following activities:

- Have each group/individual compare the similarities and differences of their prototypes. With input from the entire group, record the most successful ideas and post the results for all to see. Have youth vote on the ideas they like the best and share what the final prototypes for solar, wind and hydro might look like.
- Youth can research other types of renewable energy, share how they could use it to help Energy Island and apply the EDP to create, build, test and improve their ideas.

Educational Standards – NGSS

- 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled.



ENERGY ISLAND ADVENTURE

Playing this collaborative board game, youth work as a SUPER team to achieve a common goal: Help Energy Island move from its unsustainable carbon-based energy use to renewable solar, wind and hydro power.



Goals, Objectives and Outcomes

By the end of the activity, youth will be able to:

- Name three types of sustainable energy.
- Strategize to effectively shift Energy Island from its unsustainable carbon-based energy use to renewable solar, wind and hydro power.
- Describe challenges communities need to consider when using renewable forms of energy.

Activity Time (60 minutes)

- Intro: 5 minutes
- Activity: 30–45 minutes
- Reflection: 10 minutes

Materials

Included in kit:

- Game board
- Instructions
- Renewable Energy Tokens
- Deck of cards



IMPORTANT VOCABULARY

- **Hydroelectric Energy:** A form of renewable energy that uses the movement of water to generate electricity.
- **Non-renewable energy:** Energy from a natural resource or source of energy that is not capable of being replenished such as oil or coal.
- **Renewable energy:** Energy from a source that is not depleted when used, such as wind or solar power.
- **Solar power:** A form of renewable energy that uses power from the sun's rays to generate electricity.
- **Wind power:** A form of renewable energy that uses the movement of wind to generate electricity.

Activity Guidelines

Get Energized

To get started, ask some questions:

- When you hear the term **energy**, what do you think of?
- When you hear the term **electricity**, what do you think of?
- What is the difference between energy and electricity?
- What are some items that use energy that you can see or think of right now?
- What are some items that use electricity in your home?
- How do you think energy is produced?

Energy comes from two main sources, renewable and non-renewable. **Renewable** energy comes from a source that is not depleted when it's used. Examples include solar, wind and hydropower. **Non-renewable** energy comes from a natural resource that is unable to be replenished once it's used. Examples include oil and coal, both of which come from within the earth.

Non-renewable energy has worked in the past to help people get the energy they need, but these sources are limited and have the potential to harm the environment. This is why it's so important to create and use renewable sources of energy that provide a safer, cleaner means of energy for the health of people and the planet.

Whatever type of energy we consume, it's important to use it wisely and not waste it.

Energy Island Adventure Rules and Information

Background

Power Level: CRITICAL. Through decades of neglect and waste, Energy Island is in danger of becoming unplugged forever. Now it's in the hands of the next generation – The Power Protectors – to bring back a sustainable balance.

Objective

Players work together to upgrade the entire island with renewable energy sources – solar, wind and hydro power. Players collaborate to collect the parts needed to purchase upgraded energy sources.

Game Play

Every player draws five cards on their first turn and places them face-up on the table. Allowing players to see all cards enables the group to collaborate and work towards making Energy Island self-sustaining using renewable energy.

When it's their turn, players will:

- Draw to replenish up to the card limit based on the number of players listed on page 17.
- Resolve Caution Cards immediately by following the instructions on the card. Situation Cards may be kept for later.
- OPTIONAL: Trade cards with one player, unless they draw a card allowing them to trade with more than one player.
- To end a turn, either purchase a renewable energy source OR discard one card.
 - › To purchase a renewable energy source, a player turns in the required parts to the discard pile in exchange for a token to place on the board.
- Play continues for the allotted rounds corresponding to the number of players.

Gameplay adaptations based on number of players:

- 5-6 players: 5 cards each, play 4 rounds
- 3-4 players: 5 cards each, play 6 rounds
- 2 players: 7 cards each, play 8 rounds

Additional Rules:

- Situation Cards may be held to play later or traded with another player.
- The "Stop a Caution" Situation Card can be played by a player even if it is not their turn.
- If the person who draws the Caution Card cannot solve the problem, the next person clockwise who is able must do so. If no player in the group has the required part, the card is discarded and play continues.
- The "Discard All" Parts Caution Cards apply to all players.
- If a player picks a "Draw Two" Situation Cards they can hold more than the hand limit for that turn.
- If players need to replenish the draw pile, leave the top 10-15 cards and shuffle the remainder of the discard pile.
- Renewable Energy Tokens can be placed in any available upgrade spot on the board. Tip: Have players reference the "Levels of Success" for hints on where to place token

Game Elements

- **Board**
 - The board is a map of Energy Island showing community features with spaces allotted for renewable energy tokens.
- **Renewable Energy Tokens**
 - 6 of each renewable energy source – solar, wind, hydro
 - These tokens represent a purchased renewable energy source to be placed on the board.
- **Deck of 96 cards which includes:**
 - 69 Parts Cards
 - › Players collect parts to purchase renewable energy sources.
 - › 21 Labor
 - › 21 Generator
 - › 9 Solar Panel
 - › 9 Wind Turbine
 - › 9 Hydro Turbine
 - 15 Situation Cards
 - Situation cards present players with scenarios that provide potential benefits to help players collect parts and purchase energy sources.
 - 12 Caution Cards
 - › Caution cards introduce scenarios that present players with challenges to accomplish their goals.

Parts needed to purchase an upgrade for each type of renewable energy

- Solar: 1 Labor + 1 Generator + 1 Solar Panel
- Wind: 1 Labor + 1 Generator + 1 Wind Turbine
- Hydro: 1 Labor + 1 Generator + 1 Hydro Turbine

Levels of Success

Players' success depends on their ability to upgrade the power supply of various community features. Upgrade the locations and services listed below to achieve the corresponding level of community well-being:

- Struggling – Farm, homes
- Surviving – Farm, homes, emergency services
- Sustaining – Farm, homes, emergency services, school
- Thriving – Farm, homes, emergency services, school, transportation, town hall

Reflection

Guide youth through a discussion to reflect and make meaning of their experience.

- What is something new you learned in this activity?
- How many community locations and services did you upgrade?
- What were some of the challenges you faced when working towards upgrading community locations and services?
- What can you do differently next time to upgrade the entire island?
- How did you make decisions as a group?
- What can you do at home or in your community to promote and practice responsible energy use?

More to Explore

- The number of rounds the group plays can be altered to make the game easier or more challenging as needed.
 - › For example; when a group of five youth has finished their four rounds, take a moment to pause. Have the group assess their success. Use the reflection questions to have the group process what is working, identify their challenges and how they can adjust their strategy to upgrade more community features. After reflecting, the group can continue for another set of four rounds without resetting gameplay.
- To make the game more challenging, require each community feature to have one solar, one wind and one hydro energy token.

Educational Standards - NGSS

- MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Next Generation Science Standards (NGSS)

Standards	Superhero Hideout	Amped Up Engineering	Energy Island Adventure
3-5-ETS1-1 Engineering Design		✓	
3-5-ETS1-2 Engineering Design		✓	
3-5-ETS1-3 Engineering Design		✓	
4-ESS3-1 Earth and Human Activity	✓		✓
4-PS3-4 Energy		✓	
5-ESS3-1 Earth and Human Activity		✓	✓
MS-ESS3-3 Earth and Human Activity	✓		✓
MS-ESS3-4 Earth and Human Activity			✓
MS-ETS1-1 Engineering Design	✓	✓	
MS-ETS1-2 Engineering Design	✓	✓	
MS-ETS1-4 Engineering Design	✓	✓	

Superhero Hideout

- 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Amped Up Engineering

- 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- 4-PS3-4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled.

Energy Island Adventure

- MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- 4-ESS3-1: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
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The Engineering Design Process

The Engineering Design Process (EDP) doesn't just teach youth how to create solutions to solve problems. EDP is a cycle – the steps can be done multiple times as engineers improve solutions and get closer to their goal. Not every step needs to be completed each time.

Ask: Identify the problem, the requirements that must be met and the constraints that must be considered.

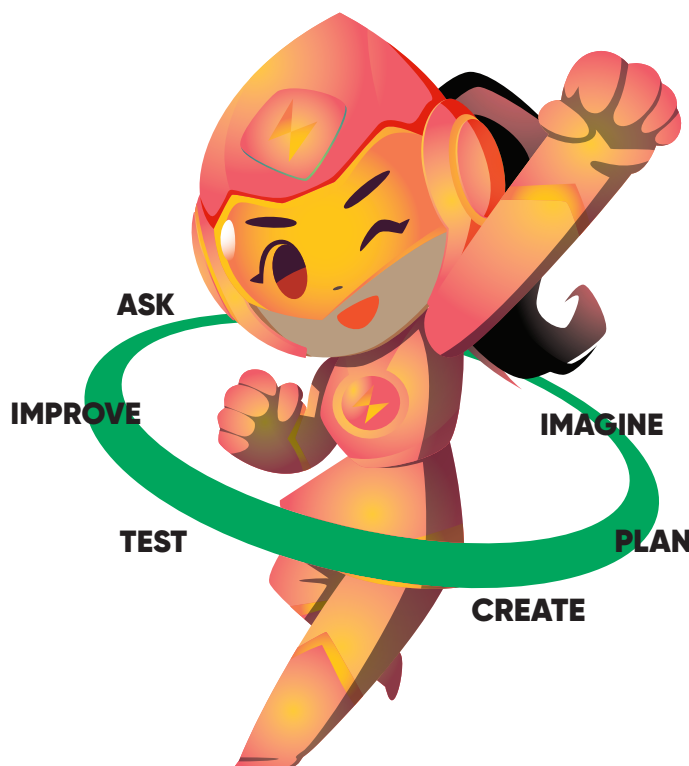
Imagine: Brainstorm solutions and research ideas, including identifying what others have done.

Plan: Choose two to three of the best ideas from the brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.

Create: Build a working model, or prototype, that aligns with the design requirements and lies within the design constraints.

Test: Evaluate the solution through testing, collecting and analyzing data, and summarizing the strengths and weaknesses of the design that were revealed during testing.

Improve: Based on the results of the tests, make improvements on the design, identify changes to make, and justify the revisions.



Enhance the STEM Challenge Experience!

Although October is officially 4-H STEM Month, youth can access and enjoy the 4-H STEM Challenge year round. With help, we can spark an interest in STEM for all youth, making hands-on learning accessible to everyone!

Preparation: Get ready to facilitate Power Protectors activities by reading through this guide. Focus on the Facilitator Preparation section for a concise overview of how to lead youth through the kit activities.

Plan: October is 4-H STEM Month and we encourage educators and facilitators to plan challenge events during this month. An event can be as simple as sharing an activity as an after-school lesson, teaching a few youth at home or hosting a larger community event. Reuse or purchase additional kits to bring the STEM challenge to more youth.

Check-in: Visit 4-H.org/programs/stem-challenge for the latest updates! This webpage is the resource to help make the most of the 4-H STEM Challenge, including promotional materials, printable resources and webinars for adults and teens.

Share: Tell your friends and colleagues about the 4-H STEM Challenge and share on social media using #4HSTEMChallenge. Feedback helps us improve the 4-H STEM Challenge each year.

CONTINUE
YOUR **POWER**
PROTECTOR'S
ADVENTURE ON
CLOVER BY 4-H,
OUR EXCITING
ONLINE LEARNING
PLATFORM! KEEP
THE FUN GOING BY
EXPLORING WIND
POWER YOU CAN
HARNESS AT HOME!
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In 4-H, we believe in the power of young people. We see that every child has valuable strengths and real influence to improve the world around us. We are America's largest youth development organization—empowering nearly six million young people across the U.S. with the skills to lead for a lifetime.

Learn more online at 4-H.org/programs/stem-challenge