WELCOME!

We're so glad you selected the ENERGY ecoSTEM Kit.
Here are some tips to help you get started.

What you can do with the ENERGY ecoSTEM Kit

Each kit contains supplies to engage a class of 32 students in exciting science and engineering practices as they solve real-world problems and learn about renewable energy. Here are some of the things students can do:

- Observe phenomena and ask questions about energy
- Design and build solar ovens to cook snacks
- Build a device to insulate a penguin ice cube
- Use copper wire and nails to design an experiment with temporary magnets
- Investigate connections between electromagnets and turbines using iron filings
- Design and build devices powered by renewable energy sources, using series and parallel circuits
- Conduct an energy audit with meters to detect energy loss; thermometers to find insulation needs
- Analyze and interpret data to determine sources of fuel used to power a community
- Design, build, test and refine a wind turbine
- Explore ways to increase solar panel effectiveness
- Contribute data to a citizen science project
- Determine the value of personal actions to reduce energy consumption and take action accordingly

Packing List

(2) Mini-SkyZ Kits, including
- 4 Wind Turbines
- 4 Solar Cells
- 4 Multimeters

(4) Kill-A-Watt EZ meters
(4) Infrared Thermometers
(2) Alt Energy Snap Circuit Kits
(2) Aluminum Foil, recycled
(32) Bioplastic Sheets
(8) Neodymium Magnets
(1) Box, 3" Steel Nails
(1) Spool, Magnet Wire (80')
(1) Packet, coarse sandpaper
(2) Ice cube trays (penguin)

Contact Us

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Access Your Energy ecoSTEM Kit QuickStart Guide Online

Teaching with the Energy ecoSTEM Kit and QuickStart Guide

Credit: Renewable Energy World

The supplies in this kit are available for teachers and informal educators to use or adapt in any way that fits their situation and teaching approach. Many states have adopted Next Generation Science Standards, and even more have embraced the pedagogy on which NGSS is based (called "three-dimensional learning") while creating their own standards. Therefore, we have arranged the QuickStart Guide to support a 3-D learning approach that can be used in ANY state. To learn more, download the free Framework for K-12 Science Education or email us to request access to our free online course.

The three dimensions in 3-D Learning are core ideas, science and engineering practices, and crosscutting concepts. The icon of a braided rope is often used to represent this model and show how the components are inextricably combined in the learning process. This differs significantly from an "inquiry" approach, because it incorporates student "sense-making" into every lesson.

In order to support 3-D Learning, ecoSTEM Kits provide an observable phenomenon to launch each learning experience. The phenomenon illustrates a mystery that students seek to figure out in the process of their investigations. No background reading, lecture or vocabulary is needed, up front. This approach emphasizes discovery and exploration before explanation, with vocabulary postponed until it appears in context. After observing a phenomenon, students talk about what they noticed and what they wondered, ask additional questions, craft tentative explanations, and conduct their own research or investigations, in small teams.

The supplies in the ecoSTEM Kit are designed to actively engage students in science and engineering practices. Each EcoSTEM Kit accommodates a class of 32 working in groups of 4. While investigating, students look for crosscutting concepts such as patterns or cause and effect, to help them make sense of core ideas. After each learning activity, students return to their initial explanations and revise them in light of new knowledge and understanding. Teachers facilitate the learning experience by guiding students in science and engineering practices, providing guardrails, conducting formative assessments, and helping clear up misconceptions.

We hope the arrangement of this QuickStart Guide will help you implement 3-Dimensional Learning, it that is your intent. You are also welcome to use the supplies for direct instruction.

Access Your Energy ecoSTEM Kit QuickStart Guide Online

Investigating ELECTROMAGNETISM Using the ENERGY ecoSTEM Kit's Nails, Winding Wire, Magnets, Iron Filings & Sandpaper

ENGAGE- Students Observe this Phenomenon

GATHER

EXPLAIN: **Construct a Tentative Explanation** → **Ask Questions** → **Conduct Research**

EXPLORE a Kit-supported Learning Experience

After observing Teach Engineering's video about making an electromagnet, students will construct an explanation of the phenomenon and try to make a model that replicates the effect, using steel nails, copper winding wire (which can be sanded on the ends to remove insulation), and iron filings. Bring your own batteries (C or D), scissors or wire cutters, and paper clips.

REASON

Draw a labeled diagram of an electromagnet → Change one thing about the electromagnet and see how its magnetism changes → Revise tentative explanation

EVALUATE (Formative Assessment)

Students should be able to explain that magnetism can produce electricity and electricity can produce magnetism. Also, students should be able demonstrate at least one factor that can cause an electromagnet to become stronger (or weaker), including how many times the wire is coiled, whether the magnet, nail or battery in the coil is part way out, whether the circuit is connected to a battery. All motors contain electromagnets.

ELABORATE

Students may try "Teach Engineering's Get Your Motor Running" investigation to see how a source of power (battery) and a magnet can create a spinning "motor" and research motors to determine which contain electromagnets (virtually all).

EXTEND

This Amazing Science video shows how to make an electromagnetic "train" with a AA battery, 18 gauge bare copper wire, and 4 – 6 disc-shaped neodymium magnets.

COMMUNICATE

EXPLAIN

After making sense of a core idea by engaging in science or engineering practices through the lens of crosscutting concepts, students revise their original explanations of a phenomenon.

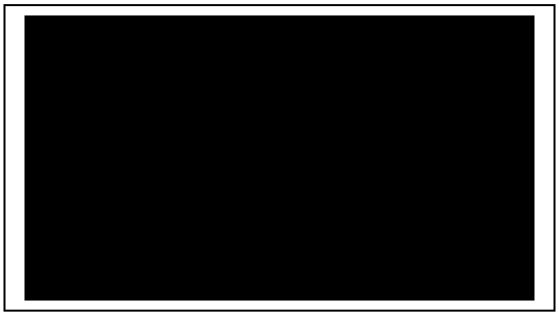
EMPOWER

Students brainstorm devices they can build that would solve a problem by creating a temporary electromagnet.

Access Your Energy ecoSTEM Kit QuickStart Guide Online

Investigating CIRCUITS Using the ENERGY ecoSTEM Kit's GREEN Snap Circuits

ENGAGE- Students Observe these Phenomena



GATHER

EXPLAIN: Build a circuit that lights a bulb → **Ask Questions** → **Conduct Research**

EXPLORE a Kit-supported Learning Experience

Students will explore the DC Circuit Virtual Lab pHet Simulation (above); make a circuit that lights a bulb using trial and error; and construct a tentative explanation. Then, they will build electrical devices powered mechanically or by wind, solar, or fruit juice using the (2) GREEN Snap Circuit Kits. The Manual contains directions for making a variety of devices such as FM radio, light, clock or buzzer. This activity is best set up as an exploration station.

REASON

Make different model circuits → Diagram and label circuits; then explain → Revise and Refine the Tentative Explanation

EVALUATE

Students should be able to explain that electricity flows in one direction, creating a loop. They may be able to explain that circuits transfer electrical energy into sound, light, and other forms; and configure a circuit using one wire, as per Page Keeley's Batteries, Bulbs and Wires probe.

ELABORATE

Students may build additional Snap Circuit models by following these videos. They may also use other pHet Simulation Labs to make bulbs light up using as many different designs as possible. This video explains circuits.

EXTEND

The Snap Circuit Designer app provides an opportunity to make drag and drop diagrams. Models may be submitted to Snap Circuit Designer Showcase for possible recognition and publication.

COMMUNICATE

Revised EXPLANATION

After making sense of a core idea by engaging in science or engineering practices through the lens of crosscutting concepts, students revise their original explanations of a phenomenon.

EMPOWERMENT

Students research sources of renewable energy and compare current usage (% by source) to historic use, to see trends.

Access Your Energy ecoSTEM Kit QuickStart Guide Online

Investigating **RENEWABLE ENERGY** Using the ENERGY ecoSTEM Kit's Sky-Z Wind Turbines, Solar Cells, & Multimeters

ENGAGE- Students Observe this Phenomenon

GATHER

EXPLAIN: Construct a Tentative Explanation → **Ask Questions** → **Conduct Research**

Play Fossil Fuels 101 video without sound

EXPLORE a Kit-supported Learning Experience

Students will design and build functional devices that are powered by renewable energy sources and measure output with multimeters. Then change a variable (such as blade shape, length, angle or number on a windmill; or angle on a solar cell) and use common household supplies (such as manila folders) to build a more effective model that increases output.

REASON

Design and Build Wind Turbines → **Collect Data on Power Generated** → **Revise and Refine the Design**

EVALUATE

Students should be able to explain that most power is generated by burning fossil fuels and creating steam to spin a turbine, which generates electricity. Solar power or photovoltaic energy is an exception, but most forms of renewable energy and nuclear power are all – at heart – just different ways to boil water to make steam to turn a turbine.

ELABORATE

Students may use the Sky-Z wind turbine kits to design and test blades of different sizes, shapes and numbers. Manila folders make good materials for crafting blades.

This film on Fossil Fuels will explain these limited resources and the Switch Project, with questions for interrupted viewing, addresses the transition to renewable energy.

EXTEND

Students may use the Handprinter app and the Drawdown web page to investigate the impact of fossil fuels on emissions, air quality, and climate; and explore alternatives and solutions ranging from individual actions to systemic change.

COMMUNICATE

EXPLAIN

After making sense of a core idea by engaging in science or engineering practices through the lens of crosscutting concepts, students revise their original explanations of a phenomenon.

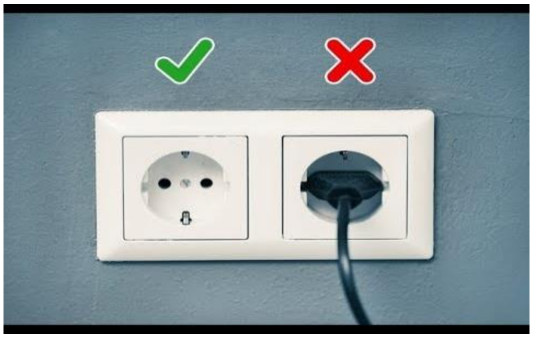
EMPOWER

Students may propose a schoolwide project to mitigate the impact of fossil fuel use or encourage use of renewable energy.

Access Your Energy ecoSTEM Kit QuickStart Guide Online

Investigating **ENERGY CONSERVATION** Using the ENERGY ecoSTEM Kit's Kill-A-Watt EZ Meters, Infrared Thermometers & Ice Cube Trays

ENGAGE- Students Observe this Phenomenon



GATHER

EXPLAIN: Construct a Tentative Explanation → **Ask Questions** → **Conduct Research**

Play video without sound

EXPLORE with a Kit-supported Learning Experience

Students will work in teams of four using KillAWatt EZ meters to test various electronics, appliances, and devices and determine how much energy they draw. Students will search for the worst "Energy Vampires" which use power even when Off or in Standby mode. They may also calculate cost savings of electricity once inefficient devices are removed.

REASON

Collect Data on Energy Use By Appliances → **Graph and Interpret Data about Energy Use** → **Revise and Refine the Tentative Explanation**

EVALUATE

Students should be able to make a claim about one electrical appliance or device that would make the most difference to disconnect from power when not in use, defend the claim by providing evidence (data), and connect the data to the claim with reasoning.

ELABORATE

This explainer video on The Surprising Places We Waste Energy will help re-teach the core ideas about energy conservation and inspire students to consider ways they can reduce energy use. Infrared thermometers can be used to locate areas of a building lacking insulation.

EXTEND

Students may watch this video about energy-saving tricks, then test the ideas in terms of validity and accuracy. A lesson from Kristi Edwards Schertz provides a more in-depth energy audit.

COMMUNICATE

EXPLAIN

After making sense of a core idea by engaging in science or engineering practices through the lens of crosscutting concepts, students revise their original explanations of a phenomenon.

EMPOWER

Students expand their energy audit to include efficient lighting, lights off practices, vampire appliances, etc. and develop a school conservation plan; compare before/after bills.

Access Your Energy ecoSTEM Kit QuickStart Guide Online

Investigating PASSIVE SOLAR OVENS Using the ENERGY ecoSTEM Kit's Recycled Aluminum Foil, Bioplastic Sheets & Tape

ENGAGE- Students Observe this Phenomenon

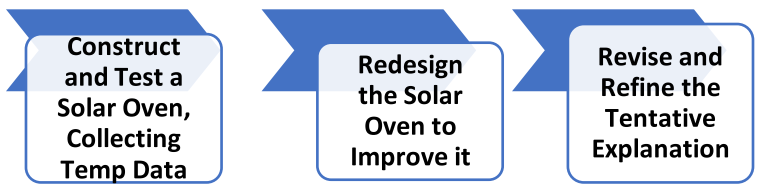
GATHER

https://www.youtube.com/watch?v=paJshg5lHuA

EXPLORE a Kit-supported Learning Experience

If the pavement is >158 degrees you can cook an egg on the sidewalk. But what can you do if it's not that hot? Students will participate in a "solar cooking race" and try to build a solar oven with the highest temperature in a set amount of time. Recycle an old container to serve as the solar oven, line the bottom and sides with colored paper or foil, create a platform or container for food, and consider whether to cover the top to focus the sun's rays.

REASON



NOTE: Choose foods that can be eaten safely if undercooked.

EVALUATE (Formative Assessment)

Students should be able to provide the rationale for design choices in their solar ovens (such as color of lining to absorb heat; material to conduct or redirect radiation; presence of a cover to focus rays or create a greenhouse effect; use of insulation; circulation for convection; etc.)

ELABORATE

Students will adopt a penguin-shaped ice cube and attempt to keep it "alive" for the longest time, by designing and building an insulated "igloo" where it can stay solid.

EXTEND

After building their own solar ovens, students may research classic designs including the Purple Fig, the Darfur Refuge Camp model, and 6 Other Solar Cookers, incorporating elements into a rebuild of their own solar cooker and re-testing of its efficiency.

COMMUNICATION

Revised EXPLANATION

After making sense of a core idea by engaging in science or engineering practices through the lens of crosscutting concepts, students revise their original explanations of a phenomenon.

EMPOWERMENT

Students can explore Nova Energy Lab and Habitable Planet's Interactive Energy Lab to conduct simulations regarding the transition to renewable energy.

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NGSS Standards for Energy ecoSTEM Kit

ecoSTEM® ENERGY Kit Alignment to Next Generation Science Standards

NGSS Standard	Grades 3-5	Grades 6-8	Grades 9-12	Learning Activity from the Kit
4-PS3-D *MS-PS3-B* *HS-PS3-B* *Conservation of Energy and Energy Transfer*	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* **Clarification Statement**: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. **Assessment Boundary:** Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. MS-PS3-3 Clarification Statement and Assessment Boundary **Clarification Statement:** Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup. **Assessment Boundary**: Assessment does not include calculating the total amount of thermal energy transferred.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects). Systems move toward stable states. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. HS-PS3-3 Clarification Statement and Assessment Boundary **Clarification Statement:** Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. **Assessment Boundary:** Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.	**Green Alternative Energy Snap Circuits** **Wind, Hydro & Solar Power Invention Kits**
4-ESS3.1 *Natural resources*	Energy and fuels humans use are derived from natural sources and their use affects the environment. Some resources are renewable over time, others are not.	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	**NOVA Energy Lab** **New Vision Solar Light**
ESS3.C *Human impacts on Earth systems*	Societal activities have had major effects on the land, ocean, atmosphere, and even outer space. Societal activities can also help protect Earth's resources and environments.	Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.	Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.	**Handprinter**

- MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.
- MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
- MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample

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GSES for Energy ecoSTEM Kit

1st grade

S1P2. Obtain, evaluate, and communicate information to demonstrate the effects of magnets on other magnets and other objects.
a. Construct an explanation of how magnets are used in everyday life. (Clarification statement: Everyday life uses could include refrigerator magnets, toys, magnetic latches, and name tags.)
b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other and the effect of magnets on common objects.

3rd grade

S3P1. Obtain, evaluate, and communicate information about the ways heat energy is transferred and measured.

a. Ask questions to identify sources of heat energy. (Clarification statement: Examples could include sunlight, friction, and burning.)
b. Plan and carry out an investigation to gather data using thermometers to produce tables and charts that illustrate the effect of sunlight on various objects. (Clarification statement: The use of both Fahrenheit and Celsius temperature scales is expected.)
c. Use tools and every day materials to design and construct a device/structure that will increase/decrease the warming effects of sunlight on various materials. (Clarification statement: Conduction, convection, and radiation are taught in upper grades.)

5th grade

S5P3. Obtain, evaluate, and communicate information about magnetism and its relationship to electricity.

a. Construct an argument based on experimental evidence to communicate the differences in function and purpose of an electromagnet and a magnet. (Clarification statement: Function is limited to understanding temporary and permanent magnetism.)
b. Plan and carry out an investigation to observe the interaction between a magnetic field and a magnetic object. (Clarification statement: The interaction should include placing materials of various types (wood, paper, glass, metal, and rocks) and thickness between the magnet and the magnetic object.)

S5P2. Obtain, evaluate, and communicate information to investigate electricity.

a. Obtain and combine information from multiple sources to explain the difference between naturally occurring electricity (static) and human-harnessed electricity.
b. Design a complete, simple electric circuit, and explain all necessary components.
c. Plan and carry out investigations on common materials to determine if they are insulators or conductors of electricity.

6th Grade

S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.
a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.
b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.

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c. Construct an argument evaluating contributions to the rise in global temperatures over the past century. (Clarification statement: Tables, graphs, and maps of global and regional temperatures, and atmospheric levels of greenhouse gases such as carbon dioxide and methane, should be used as sources of evidence.)

8th Grade

S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system.
a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.
b. Plan and carry out an investigation to explain the transformation between kinetic and potential energy within a system (e.g., roller coasters, pendulums, rubber bands, etc.).
c. Construct an argument to support a claim about the type of energy transformations within a system [e.g., lighting a match (light to heat), turning on a light (electrical to light)].
d. Plan and carry out investigations on the effects of heat transfer on molecular motion as it relates to the collision of atoms (conduction), through space (radiation), or in currents in a liquid or a gas (convection).

S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.
a. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact.
b. Plan and carry out investigations to demonstrate the distribution of charge in conductors and insulators. (Clarification statement: Include conduction, induction, and friction.)
c. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) that affect the strength of electric and magnetic forces. (Clarification statement: Including, but not limited to, generators or motors.)

High School Physical Science

SPS7. Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.
a. Construct explanations for energy transformations within a system. (Clarification statement: Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.)
b. Plan and carry out investigations to describe how molecular motion relates to thermal energy changes in terms of conduction, convection, and radiation.
c. Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels).
d. Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves

SPS10. Obtain, evaluate, and communicate information to explain the properties of and relationships between electricity and magnetism.
a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.
b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits. (Clarification statement: Advantages and disadvantages of series and parallel circuits should be addressed.)
c. Plan and carry out investigations to determine the relationship between magnetism and the movement of electrical charge. (Clarification statement: Investigations could include electromagnets, simple motors, and generators.)

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