

# EDUCATOR GUIDE

# SOLARVILLE

This guide introduces concepts and activities for educators to use with their students centered around the *Solarville* gallery at Arizona Science Center. This guide contains activities that are aligned to state standards and are organized by grade band.



Never stop wondering.  
Never stop imagining.™

# EXHIBITS OVERVIEW AND CONCEPTS

## DISCOVER ALGAE FUEL

Watch a video about how scientists make fuel out of algae. Learn that this is a sustainable source of energy because the algae uses carbon dioxide from the air as it grows!

**Concepts:** *Renewable Energy, Sustainability, Carbon Cycle*

## ROAD TO RENEWABLE ENERGY

Visit the kiosk to watch short videos explaining how we get energy from solar, wind, water, biomass and geothermal sources. Also read signs on the pros and cons of both renewable and nonrenewable energy sources.

**Concepts:** *Renewable Energy, Sustainability, Nonrenewable Energy Sources*

## WIND POWER

Turn on the wind and watch as it spins the turbine to light an LED!

**Concepts:** *Renewable Energy, Kinetic Energy, Wind Power*

## POOP TO POWER

Did you know that a cow's poop can light up your house? Learn how waste is turned into biogas!

**Concepts:** *Renewable Energy*

## MUSCLE MATCH

Race the solar panel! Crank the handle on your side to make the ball rise to the top of the tube—and see if you can beat the solar-powered tube.

**Concepts:** *Renewable Energy, Solar Power*

## HOW A SOLAR PANEL WORKS

Investigate the different layers of a solar panel and how they're combined to help us trap the Sun's energy and create electricity!

**Concepts:** *Solar Energy, Electrons, Electricity*

## SMART WINDOWS

Test an energy-saving window that goes from clear to opaque with the flip of a switch.

**Concepts:** *Saving Energy, Sustainability*

## WHY BIRDS DON'T GET ZAPPED

Why can birds sit on telephone wires and not get electrocuted?

**Concepts:** *Electricity*

## MAKE A SPARK

Use heat to create a spark that travels up the Jacob's ladder, then cool it off and see what happens.

**Concepts:** *Electricity*

## COMPACT YOUR CARBON

Learn about solar trash compactors with our replica. Solar energy allows us to squeeze more garbage into our trash cans, which means the garbage trucks don't need to burn fossil fuels to collect the trash as frequently!

**Concepts:** *Trash Collection, Solar Power, Climate Change*

## SKIN TONES

Different areas of the world have different amounts of sunlight, which is why we see a variety of skin tones as people have adapted to their climate.

**Concepts:** *Sun, Adaptation*

## PEDAL POWER

Ride a bike and use your own power to light up three different kinds of light bulbs: incandescent, fluorescent and LED. Which one takes the most energy?

**Concepts:** *Electricity, Energy, Sustainability*

## ECOSPHERE

Our colony of shrimp has been surviving in a self-contained glass sphere for over 12 years! The shrimp eat algae, which grows in sunlight, and bacteria break down waste.

**Concepts:** *Ecosystems*

## URBAN HEAT ISLAND

Compare the temperatures of concrete and plants. Is one warmer than the other? Why? What does that mean for cities like Phoenix?

**Concepts:** *Urban Heat Island Effect, Sustainability*

## UNPLUG!

Did you know that most Americans have vampires in their homes? That's right—energy vampires are plugs that suck up energy when they are left plugged into the wall! Experiment with different appliances to see which ones use the most energy.

**Concepts:** *Electricity, Sustainability*

## DESERT DWELLINGS

Examine different materials that are commonly used to build homes in the desert. Which materials would keep your house the coolest in the hot summer sun?

**Concepts:** *Sustainable Buildings, Heat Capacity*

## RECYCLING

Take a quiz to see how much you know about recycling and pick up some tips on how to recycle more in your life.

**Concepts:** *Recycling*

## WHY IS THE SKY BLUE?

Take a look at how sunlight shines through the sky and learn about why the sky appears blue.

**Concepts:** *Light Spectrum, Sun*

## SOLAR AT WORK

Head out to the APS Solar Terrace to get a view of the solar panels that Arizona Science Center uses to power our annex building.

**Concepts:** *Solar Power*

## SCREEN THE SUN

Test different materials, like sunscreen and denim, to see which one lets more UV light through.

**Concepts:** *Ultraviolet Light, Sun Protection*



## ESSENTIAL QUESTIONS

These four questions provide the framework for guiding learning through *Solarville*:

1. How has our electricity use changed over time?
2. What new technologies promote renewable resources?
3. How is solar energy stored by living things?
4. Compare two types of renewable resources demonstrated by the gallery.

## EDUCATOR RESOURCES ALIGNED TO EXHIBIT STANDARDS



GREENHOUSE  
EFFECT



NATURAL  
RESOURCES



SUN AS ENERGY



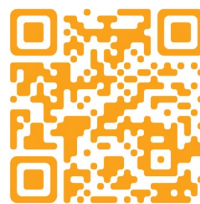
ENERGY  
SOURCES



RENEWABLE OR  
NONRENEWABLE



HUMAN IMPACT



ENERGY FLOW



PLANT ENERGY

# EXHIBIT STANDARDS BY GRADE LEVEL

## 2018 ARIZONA SCIENCE STANDARDS

### KINDERGARTEN

**K.E1U1.4** Observe, describe, ask questions, and predict seasonal weather patterns; and how those patterns impact plants and animals (including humans).

### GRADE 1

**1.E1U1.5** Obtain, evaluate, and communicate information about the properties of Earth materials and investigate how humans use natural resources in everyday life.

### GRADE 3

**3.E1U1.4** Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems.

**3.L2U1.7** Develop and use system models to describe the flow of energy from the Sun to and among living organisms.

### GRADE 4

**4.P4U3.4** Engage in argument from evidence on the use and impact of renewable and nonrenewable resources to generate electricity.

### GRADE 6

**6.E1U1.6** Investigate and construct an explanation demonstrating that radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere.

**6.L2U3.11** Use evidence to construct an argument regarding the impact of human activities on the environment and how they positively and negatively affect the competition for energy and resources in ecosystems.

### GRADE 7

**7.L2U1.12** Construct an explanation for how some plant cells convert light energy into food energy.

### GRADE 8

**8.E1U3.8** Construct and support an argument about how human consumption of limited resources impacts the biosphere.

**PRE-VISIT ACTIVITY**

**WHAT'S  
THEIR USE?**

**GRADES K-2**

# WHAT'S THEIR USE?

## OVERVIEW

Mother Nature is pretty spectacular! From lush, green forests to crashing waves on sandy beaches, the environments on Earth are vast and full of resources. Humans use these natural resources from Earth's materials for a variety of reasons, including using soil and water to grow crops, using wood to provide heat and/or to build shelters, and mining minerals like iron and copper to make usable items. In this lesson, students will engage in a card-sort activity to investigate how humans use natural resources in everyday life.

## BACKGROUND

Living things need water, air and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.

## MATERIALS

- Science journal (1 per student)
- Pen or pencil (1 per student)
- [What's Their Use? Card Sort Mat](#) (1 per group of students [pre-cut])
- [What's Their Use? Card Sort Mat](#) (1 per student)
- Glue

## ARIZONA STANDARDS

**1.EIU1.5** Obtain, evaluate, and communicate information about the properties of Earth materials and investigate how humans use natural resources in everyday life.

## 5E LEARNING CYCLE

### ENGAGE

Tap into prior knowledge. Remind students that they have learned about natural resources in the past. Ask them to name various natural resources and what makes them a natural resource (made from Earth-created materials). List types of natural resources on the board (here is a good time to ensure that there are no misconceptions about what a natural resource is).<sup>1</sup>

# WHAT'S THEIR USE?

## EXPLORE

After creating the class list, have students do a “Resources Walk” around the class. Invite students to walk around the classroom (in pairs or independently) and take notice of items that are made from natural resources.<sup>2</sup> After a few minutes of exploring, have each student (or pair) find one natural resource item to stand by (everyone must find something different). Have students take turns showing their item. As they show, ask the student what natural resource was used to make that item. While students share, make a list on the board of the items discovered, sorting them by material.

## EXPLAIN

Once all students have had the opportunity to share their item, discuss the different uses for each item as a class. What is a desk used for? Etc.

Remind students that natural resources are used by humans in all aspects of life, not just in the classroom! Present students with the What's Their Use? Card Sort Mat. Read through each of the items and explain how they will work in teams to decide where to place the “use” on the mat (under the correct “material”). Allow students time to work in teams to discuss and place (not glue!) their items. As students work, monitor the students and note any misconceptions.

Once teams have had sufficient time to complete the mat, discuss where items were placed, why they were placed there and come to a consensus about where everything should go as a class. Allow students to correct their sorts as the discussion is held, and glue as decisions are made.

## EXTEND

Students will go home and find one item in their home that represents each of the natural resource materials from the lesson today (wood, water, soil and minerals). Once they've identified each material, they will draw a picture or write what it is, identify what it's made of, and how they use it in their science journals.

## EVALUATE

Provide students with a blank What's Their Use? Card Sort Mat. Direct students to draw or write one item from the classroom under each material.<sup>3</sup>



# WHAT'S THEIR USE?

## DIFFERENTIATION SUGGESTIONS

1. Show students pictures or samples of different natural resources. Guide students in a discussion about what makes them a natural resource. Ask students to work with a partner and think of a natural resource that is not on the board. As a class, ask students to share.
2. Give students a scavenger hunt with a specific list (words or pictures) of items that are made from natural resources. Ask students to find and/or collect them (examples: pencil, paper, etc.).
3. Provide students with two or three choices for each section and allow students to select their answer.

**PRE-VISIT ACTIVITY**

**RESOURCE  
RESPONSIBILITY**

**GRADES 3-5**

# RESOURCE RESPONSIBILITY

## OVERVIEW

Natural resources fall into two categories: renewable resources and nonrenewable resources. These natural resources are used by people to create electricity (example: energy radiated from the Sun is transferred to Earth by light). Cost-benefit analysis of a resource helps to provide information about the environmental impact of a natural resource. In this activity, students will determine if the natural resource is renewable or nonrenewable, and evaluate its impact on the environment in order to guide decisions about obtaining energy for their home.

## BACKGROUND

The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use. Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time and others are not.

## MATERIALS

- [Natural Resource Card Sort](#)
- [Natural Resource Cost-Benefit Analysis handout](#)
- Scissors
- Pencil
- Items made from natural resources

## ARIZONA STANDARDS

**3.E1U1.4** Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems.

**4.P4U3.4** Engage in argument from evidence on the use and impact of renewable and nonrenewable resources to generate electricity.

## 5E LEARNING CYCLE

### ENGAGE

Show students a variety of items made from natural resources (pencils, paper, metal, salt, etc.). Ask students if they can find any commonalities among the items. They might mention the materials are all natural, that they are items humans use or they might sort them by material. Lead students to the understanding that all the items are created for human use from natural resources.

Have students name all of the natural resources that humans use and list them on the board. This list should be derived from the items shown and also from prior knowledge. The list should include: wind, soil, meat from animals, water, wood, coal, rock for building with, oxygen, metals like aluminum cans, cotton for clothes, flowers, gemstones, oil, natural gas and sunshine.

# RESOURCE RESPONSIBILITY

## TEACHER TIPS

1. Consider having images or examples of all that is listed here to help with the production of the list. Ask students to define natural resources based on what they have learned in previous years or lessons.
2. Natural resources are materials that occur in nature that can be used by people. Natural resources include water, plants, minerals and more.

## EXPLORE

Ask the students to look at the list of natural resources again and pose the following question: Looking at all of these resources, which do you think will be here forever and which might be “used up”? Allow students time to discuss their thoughts in pairs.

Once students have had time to discuss with their partners, have the whole class work together to sort the items based on whether they will be “used up” or not. When students have finished sorting as a class, provide them with the terminology “renewable” and “nonrenewable” to describe the items.

Let’s look at renewable first. What does it mean to renew something? For example, I renewed the book *Harry Potter and the Sorcerer’s Stone* from the library. “Renew” means to have it again. A renewable resource is a material that cannot be used up, or it can be renewed or replaced within a human lifespan.

Now let’s look at nonrenewable. When we put the prefix “non” in front of a word, what does that do to the meaning of the word? For example, I cooked my scrambled eggs in a nonstick pan. “Non” means “not”. A nonrenewable resource is a material that is found in nature that can be used up or cannot be replaced in a human lifespan.

Now that the renewable vs. nonrenewable resources have been identified, inform students that humans use these various natural resources for different things. Which ones are used for food? Which are used for making shelter? Are any used for supplying energy?

Focus on the items used for energy. We have a variety of different resources that we can use to provide us with energy to create electricity for our everyday use. Present students with the Natural Resource Card Sort and have them sort the energy providing resources into renewable or nonrenewable piles. **Teacher Tip:** Review the images first.

# RESOURCE RESPONSIBILITY

## EXPLORE CONTINUED

Once the resources have been sorted, discuss and ensure that students all can correctly identify the renewable vs. nonrenewable sources.

When considering how we use natural resources to make electricity, we don't only consider how quickly they can be replaced, we also need to consider how using those resources impacts the environment. Electricity is something we use in abundance in our everyday lives. Let's do a cost-benefit analysis of these resources to better understand the impact on the environment each one has. Pass out the Natural Resource Cost-Benefit Analysis document to each student and give them the following directions:

1. On this handout, each renewable and nonrenewable resource has two statements. Read each statement and decide if the impact of using that resource is positive or negative.
2. Place a check mark in the box that matches your selection: positive or negative.
3. Be ready to explain your answers during the whole group discussion.<sup>1</sup>

## EXPLAIN

Review the students' answers to the Cost-Benefit Analysis handout using the following question prompts:

- Which descriptions do you think are positive?
- Which descriptions do you think are negative?

*Note: Students should come to the realization that all the resources have trade-offs when used for energy.*

# RESOURCE RESPONSIBILITY

## EXTEND

Students will research what other countries are doing with their renewable and nonrenewable resources. What is their main source of energy for electricity in that country? How is their country doing fiscally?<sup>2</sup>

## EVALUATE

Have students respond to the following prompt in writing: Now that you know there are positives and negatives to all ways of making electricity using natural resources, which method would you choose to make the least negative impact? Why?<sup>3</sup>

# RESOURCE RESPONSIBILITY

## DIFFERENTIATION SUGGESTIONS

1. Write on the board that a positive impact is good, and a negative impact is bad. Picture supports can also be provided as necessary. For additional support, this activity can be done as a whole group, small group or with a partner.
2. Give students more support by providing them with a list of a few different countries that they can research. Provide specific websites or materials that students can use. Video resources are always a plus for students who prefer visual learning.
3. Give students more support by providing them with a choice of how to show their understanding. This may include drawing pictures, giving a verbal presentation, recording themselves answering the question verbally or completing provided sentence stems.

**PRE-VISIT ACTIVITY**

# **EARTH'S BLANKET**

**GRADES 6-8**



# EARTH'S BLANKET

## OVERVIEW

Earth's atmosphere is a transparent layer of gases that allows sunlight to pass through, reaching and warming Earth's surface. The radiation from the Sun absorbed by the Earth warms the surface which then emits radiation of longer wavelengths (infrared) that do not pass through the atmosphere but are absorbed by it, keeping the Earth warm. This is called the greenhouse effect because it's similar to the way the inside of a greenhouse is heated by the Sun. Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, regulating Earth's average surface temperature and keeping it habitable for life on Earth. Climate change is a multidisciplinary issue, concerning the world's scientists, politicians, humanitarian organizations and global citizens alike. In this investigation, students will discover one of the causes for increased global air temperatures in order to explain that radiation from the Sun provides energy, and is absorbed to warm the Earth's surface and atmosphere.

## BACKGROUND

The radiation from the Sun absorbed by the Earth warms the surface which then emits radiation of longer wavelength (infrared) that does not pass through the atmosphere but is absorbed by it, keeping the Earth warm. Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, regulating Earth's average surface temperature and keeping it habitable.

## RESOURCES



[Global Action on Climate Change Video](#)



[NASA's Climate Time Machine](#)



[EPA's Carbon Footprint Calculator](#)

## ARIZONA STANDARDS

**6.E1U1.6** Investigate and construct an explanation demonstrating that radiation from the Sun provides energy and is absorbed to warm the Earth's surface and atmosphere.

**8.E1U3.8** Construct and support an argument about how human consumption of limited resources impacts the biosphere.

## MATERIALS

- Science journals (1 per student)
- Pen or pencil (1 per student)
- Sealable bags (2 per student group)
- Cups of room temperature water (2 per student group)
- Measuring spoons (1 per student group)
- Sodium bicarbonate (baking soda) (1 tablespoon per student group)
- Thermometers (2 per student group)
- Markers (1 per student group)
- Timers (1 per student group)
- Access to a sunny windowsill or sunny spot outside
- [Earth's Blanket handout](#)

# EARTH'S BLANKET

## 5E LEARNING CYCLE

### ENGAGE

Introduce the topic of today's lesson by asking students the following question: How many of you have heard about climate change? Give a thumbs up or down to show if you have heard of it before.

Once students have shown if they have heard the term climate change, inform them that they will be exploring this concept today.

In 2017, Secretary-General António Guterres was in office in the United Nations, and he presented a "call to action" in regards to climate change. Before playing the video, inform students that they will need to keep in mind two questions while watching:

- What is the problem the Secretary-General is posing to the global community?
- Who is he calling to action?<sup>1</sup>

Play the video for the students [Global Action on Climate Change](#) in its entirety. After playing the video, facilitate a class discussion of the following questions:

- What is the problem the Secretary-General is posing to the global community?
- Who is he calling to action?

The Secretary-General seems very concerned about climate change! This must be an important issue. Let's look at some data to help better understand why the Secretary-General has these concerns. Display [NASA's Climate Time Machine](#) on the screen. Then, click on Global Temperature.

This model shows how global temperatures have changed over time. Prompt students to take notes<sup>2</sup> of any significant changes while the images are playing. Make sure to inform students about the map features so they are able to interpret the data.

After showing the map, prompt a class discussion. Discuss the significant changes they noticed. What effects might the increase in temperature have for life on Earth?

*Example: Habitat changes for animals.* Continue to explore this by showing the maps for the "ice levels" and "sea levels". As these are shown, prompt students to discuss what they notice about the changes (water rising, ice lessening) and what those changes might mean for life on Earth. As they can see, climate change can have a significant impact for life on Earth!

# EARTH'S BLANKET

## EXPLORE

Now that students have a better idea of what climate change is and that it has an effect on life on Earth, it's important to understand how and why that change is occurring. To do this, students will engage in an exploration.

One of the differences that scientists have seen as a result of global climate change is a change in the average air temperature. In order to understand how something has changed, students need to understand what it was like before the change.

Students will work in teams of four to create a model for how Earth's air temperature changes. Distribute the Earth's Blanket handout to each student and the investigation materials. Student groups will work together to develop a model for the greenhouse effect.

*Set the stage for the greenhouse model:*

To begin our investigation, consider our experiences with Earth's temperatures. When you're outdoors and it's cold, how would you warm yourself? Just like we have blankets to wrap around us and keep us warm, Earth has a system for keeping warm—and it's a good thing too! Earth historically has an average temperature of about 60° Fahrenheit, which helps the organisms on Earth stay alive! Now, of course Earth doesn't have a blanket, it uses other means to help maintain the temperature. Let's explore exactly how this is done by engaging in the following investigation:

1. Using a marker, label a bag as "Without Carbon" and the other bag as "With Carbon".
2. Add 1 tablespoon of sodium bicarbonate (baking soda) to the "With Carbon" bag.
3. Add 1 cup of room-temperature water to the bag.
4. Measure the temperature of the water with a thermometer and record this temperature in their science journals. Make additional observations of the bag and record observations.
5. Seal the bag, mix the water and sodium bicarbonate well by swishing the bag from side to side, then set aside.
6. Add 1 cup of room-temperature water to the bag labeled "Without Carbon".
7. Measure the temperature of the water with a thermometer and record this temperature in their science journals. Make additional observations of the bag and record observations on the Earth's Blanket handout.

# EARTH'S BLANKET

## EXPLORE CONTINUED

8. Seal the bag.
9. Place both bags next to each other in a sunny spot on your windowsill or outside.
10. Set a timer for 5 minutes. When the timer sounds, measure the temperature with a thermometer for both bags by opening the bag and putting the thermometer into the water. Record the temperatures and observations.
11. Continue to make observations of the bags and measure the temperatures every 5 minutes for the next 20 minutes. Record all results in science journals

## EXPLAIN

Now that students have had the opportunity to explore, help them to make connections from the model to the issue of climate change by discussing the following questions:

1. Looking at your data, which bag was better at gaining heat?
2. Where did the heat come from to warm up the water?  
**Teacher Tip:** Earth gets most of its energy from the sun, called solar energy.
3. Why did the bag with the baking soda heat faster?  
**Teacher Tip:** Light energy was trapped in the bag with the baking soda. Sodium bicarbonate (baking soda) has carbon in it. Carbon dioxide, a gas found in our atmosphere, has the ability to trap more heat from the Sun, just like the sodium bicarbonate! Scientists define greenhouse gasses as gasses in Earth's atmosphere that trap heat. They let sunlight pass through the atmosphere, and capture that Sun's heat energy preventing it from leaving Earth's atmosphere. Excellent greenhouse gasses include carbon dioxide, water vapor and methane.

# EARTH'S BLANKET

## EXPLAIN CONTINUED

Using the evidence you collected, make connections from the model to the issue of climate change. The bags represent Earth's atmosphere, and scientists define the atmosphere on Earth as the layers of gasses above Earth's surface. Have students answer the following questions:

1. What does the temperature inside the bag with and without the sodium bicarbonate represent in the natural world?
2. How would more carbon dioxide in Earth's atmosphere impact the temperatures on Earth?

One of the reasons we're seeing increases in global temperature is the added carbon molecules to Earth's atmosphere. These added carbon molecules get into the atmosphere as a result of burning fossil fuels like coal, oil and by industrialization. As we can see, there are human actions that are contributing to the effects of climate change!

## EXTEND

Students can explore their impact on Earth's climate using a carbon footprint calculator. Allow students to explore the carbon footprint calculator [here](#). Monitor and assist as needed. Students can explore ways to lower their carbon footprint. Provide time for them to discuss their discoveries.

Students can also take time to research ways in which we are producing carbon using natural resources (coal and oil for energy) and the impact of this. Are there alternate resources we can use to produce energy that will help us lessen carbon emissions?

## EVALUATE

After students complete their investigations, provide the following prompt to write in their science journals<sup>3</sup>: It seems like there are a lot of ways climate change has impacted the world, such as rising global temperatures, sea ice melting and sea level changes! Based on your investigations and class discussions, how would you describe climate change? Based on your investigations and class discussions, would you say that Mr. Guterres' call to action is justified? Why or why not? Cite specific evidence to support your response.

# EARTH'S BLANKET

## DIFFERENTIATION SUGGESTIONS

1. Have a discussion before watching the video to make sure that students understand the questions being asked. One teaching strategy that can be used is to have students rephrase the question(s) with a partner.
2. Provide students with guiding questions or sentence stems to use while doing the investigation.
3. Give students more support by providing them with a choice of how to show their understanding. This may include drawing pictures, giving a verbal presentation, recording themselves answering the question verbally or completing provided sentence stems.

# BOOK YOUR FIELD TRIP TODAY!

If you have a group of 15 or more,  
you are eligible for group discounts!  
To schedule your field trip or group visit, head to  
**AzScience.Org.**



Never stop wondering.  
Never stop imagining.™