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ENERGY!

Part 3:

Energy and Cooking

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian
Science Education Center

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

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PART 3: ENERGY AND COOKING

Find out More!

For additional resources and activities, please visit the *Energy!* StoryMap at http://bit.ly/3Kx41Jy.

Planner

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 1: How do we use energy to cook food in our community?					
Discover	Describe a meal that is important to you, who cooks it, and what energy source is used to cook it.	• Large piece of paper • Pens or pencils • Art or craft materials (optional)		25 minutes	64
Understand	Carry out an investigation into the effects of cooking.	• Paper • Pens or pencils • Watch or clock Optional • Humidity monitor • Thermometer • Smoke detector • Particle monitor • Card with petroleum jelly		15 minutes + investigation time	66
Act	Examine different perspectives and identify what concerns your team the most about cooking in your community.	• Paper • Pens or pencils	*How We Cook* *Cooking in my Community* chart *Energy Source Cards*	20 minutes	74

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: How can we use sustainable energy to cook in the future?					
Discover	Explore your team's priorities for cooking. Carry out a survey to assess your community's priorities for cooking.	• Paper • Pens or pencils		25 minutes + survey time	77
Understand	Investigate two sustainable sources of energy for cooking by building a model of biofuel pellets and a solar stove.	• Paper • Cardboard or other sturdy material • Reflective surface • Small container Optional: • Ruler • Scale • Thermometer • Butter, ghee, coconut oil		40 minutes for the biofuel pellets model 60 minutes for the solar stove model	82
Act	Add information to your *Futures Mood Board* and continue ranking your *Energy Source Cards*.	• Pens or pencils	*How We Cook* *Concerns List* *Futures Mood Board* *Community Priorities* *Energy Source Cards*	15 minutes	89

Meet Your Research Mentor

Meet Karuna Bajracharya. Karuna (pronounced *Kah-ROO-nah*) will be your research mentor to help you understand what kinds of **sustainable energy** can be used for cooking and how communities make decisions.

Karuna is the country manager in Nepal for the Clean Cooking Alliance. The Clean Cooking Alliance is an organization that helps communities use safer and more sustainable sources of energy for cooking. Karuna has advanced degrees in business and social science. However, she also has knowledge and **perspectives** that come from other parts of her **identity**. Since Karuna is now working with you, it is important to understand who she is.

Karuna's Identity Map

Female	56 years old
Nepalese (Newar ethnicity)	Is 1.8m (5'11")tall
Lives in Nepal	Has black hair
Enjoys trekking and gardening	Likes to help others
Is shy at first	Likes clean cooking, sustainability
Mother of two young children	Is a clean cooking expert in her community
Believes everyone has special qualities and capacities	"There is no such thing as intelligent or unintelligent."

Task 1: How do we use energy to cook food in our community?

Cooking is something that happens around the world every day, sometimes multiple times a day. People use all kinds of sources of energy to prepare food that helps them live, work, and grow. Some of those sources of energy are more sustainable than others. And some of those sources of energy are safer than others.

In this task you will ***discover*** why cooking is important to you. Then you will work as a team to ***understand*** how cooking can affect the people in your **community**. Finally, you will ***act*** to identify your biggest **concerns** about cooking in your community.

Before you begin the rest of Part 3, think quietly to yourself about Karuna's identity map.

- Are there things you have in common with Karuna?
- Are there ways in which you are different from Karuna?
- Can you see anything about Karuna's identity that makes it easier for her to help a community find safer and more sustainable energy sources for cooking?

During Part 3 you will notice Karuna sharing ideas and experiences with you. She may help you understand better ways to do your research or share some of the research she has done.

Discover: *How do we cook food?*

Have you ever cooked part or all of a meal yourself? Think about who helped or taught you how to cook. They might have told you what kind of cooking surface to use, which ingredients to use, where to cook, and why that meal was important to them. Cooking is an activity that is often passed from person to person in a community or between communities.

How we cook food is related to our **traditions**, likes and dislikes, the people around us, and the sources of energy we have **access** to. You will explore all of those in this activity.

1. Partner with another team member.
2. Share your answers to these questions with each other:
    a. Think of a meal that is important to you or that you really enjoy. Describe how it tastes, smells, feels, sounds, or looks.
    b. Who usually prepares this meal?
    c. What source of energy is used to prepare this meal? For example, a natural gas stove, a wood fire, a charcoal grill, or an electric stove that is powered by a nuclear **power plant**.
3. Notice and then discuss with your partner what is similar and different about your answers. Ask why the meal is important to them.

Figure 3.1: This family is sharing a special meal to break their fast during Ramadan.

4. Gather as a team.
5. Get out a large sheet of paper or a shared digital document. Title it "How We Cook."
6. Share your answer to the first question (Step 2a) by recording it on the paper. Feel free to use photos, drawings, colors, symbols, words, or anything else to represent your description of the meal.
7. Ask other team members to add their answers to the paper.
8. Examine other people's answers by drawing lines, underlining, circling, or using another way to show connections between the meals. Notice and discuss what is similar and different. Ask your team members to explain why the meal they described is important to them.
9. Repeat Steps 6, 7, and 8 for the other two questions (Step 2b and Step 2c).

10. Discuss these questions with your team:
    a. What did you notice about why certain meals are important to your team members?
    b. What was the most common answer for who prepares the meal?
    c. What was the most common answer for source of energy?
    d. What other patterns did you notice? If you want to explore more about food in your community you can use the *Food!* guide.
11. Save this *How We Cook* document. You will need it at the end of this part.
12. Read Karuna's ideas about sources of energy for cooking in Nepal. Did your team list any of the same sources of energy?

Karuna Says . . .

Many people in **rural** areas and communities outside of the city in Nepal use LPG, or **liquefied petroleum gas**. But they only use LPG 10% of the time because it is expensive. They might use LPG to quickly boil water for a guest who has shown up, but not for cooking an entire meal.

Electricity is expensive in rural areas. In the past, most people used it just for lighting. Their houses were not set up to use electricity for cooking. In recent times, there has been a huge investment in **hydropower**. So soon, Nepal will have a **surplus**, or extra amounts, of energy—in about two years.

Understand: *How does energy for cooking affect my community?*

In the Discover activity, you thought about how cooking is a part of your life, why it's important to you, and how energy is used to make meals you love. Why is it so important to think about cooking?

Cooking can sometimes produce **particulates** or **gases** that are harmful to the people nearby. Particulates are small bits of matter floating in the air. Sometimes

those harmful particulates and gases come from the source of energy being used. For example, a wood fire produces **carbon monoxide**, a gas that can be harmful to people. Sometimes particulates and gases come from the food that is being cooked. If you have ever noticed grease near your cooking surface after frying a food, then you have observed a particle that comes from cooking.

You can make cooking a safer process by investigating how people and spaces are affected by cooking. In this activity, you will collect **data** about the effects of making a meal.

1. Read Karuna's ideas and think about them on your own. Consider these questions:
   a. What effects of cooking are you concerned about?
   b. What ideas do you now have about investigating the places in your community that are used for cooking?

Karuna Says . . .

In Nepal, some people use **loose biomass,** like dried animal dung, maize stalks, rice straw, or small twigs and sticks as energy sources for cooking. Other people use firewood. Loose biomass and firewood can produce a lot of smoke. The smoke gets trapped inside the house.

Some stoves in Nepal are made from mud and brick. They are **inefficient.** When you light a fire in an inefficient stove, the fire can release harmful gases like **sulfur dioxide**, **nitrogen dioxide**, and carbon monoxide. It can also release particulates that are very small and can get into the small spaces of your lungs. These particulates can cause **cataracts**, asthma, wheezing, coughing, and even lung cancer. Because children tend to be around the kitchen with their mothers, they can also be exposed to the risk.

2. Gather as a team.
3. Read *Cooking Investigation* and decide how you will investigate. Carry out your investigation and collect your data.

Cooking Investigation

You are going to investigate one or more places in your community that are used for cooking. You will examine who is doing the cooking, what source of energy is used for cooking, and how each place is affected by cooking.

Choose a Place to Investigate

a. Work with your team to choose a place in your community that you want to investigate. It should be a place where cooking happens. It could be in your school, a household, a community center, a mobile kitchen, an outdoor kitchen, a restaurant, or another place. You can choose more than one place.

Choose How to Investigate

a. Work with your team to decide how and where to record your observations.
b. Decide who will use the tools and make measurements and who will record the measurements and observations.

Choose What to Investigate

a. You and your team are going to collect data about the effects of cooking. You can choose to investigate who is doing the cooking, the source of energy, or how a space changes during cooking. This will help you figure out how cooking affects people in the space.

⚠ Emotional Safety Tip

Cooking is very personal and it often happens in people's homes. It might not feel comfortable to invite others to your home or to visit other people's homes for this investigation. And you might feel nervous about investigating how cooking affects the people you are close to. It is okay to choose another place to investigate, like a restaurant or a community cooking space.

⚠ Physical Safety Tip

Cooking involves heat. Sometimes that heat comes from fire, such as a wood fire or a gas stove. Fire can be dangerous. Be careful around fire and other hot surfaces and pay attention to instructions from adults who are cooking in the space.

Choose one or more of the investigations listed here:

Who Is Doing the Cooking Investigation

Record who is doing the cooking. Ask the person if they are comfortable telling you about their identity, such as their age or gender.

Source of Cooking Energy Investigation

Find out what source of energy is used for cooking.

a. Some common sources are firewood, natural gas, liquefied petroleum gas, alcohol such as ethanol, biomass, or electricity.
b. If the source is electricity, find out how that electricity is generated. For example, is it from a solar panel? A hydroelectric dam? A coal power plant?

Cooking Area Observation

Describe the physical space where the cooking is happening. You might want to use words, drawings, photographs, sound recordings, or video recordings. Observe whether there are windows, fans, doors, or openings to other rooms or to the outdoors in the cooking space.

Cooking Ventilation Investigation

Ventilation adds fresh air to a space and helps move harmful particulates and gases out of a space. Ventilation helps keep people safe from the particulates and gases produced by certain sources of energy and the food that is being cooked.

It isn't always easy to measure the ventilation in a cooking space, so you can pay attention to temperature, humidity, smells and smoke instead. If you notice that it gets very hot, humid, smelly, and smoky in a space, and it doesn't go away quickly after cooking stops, the space may not be well ventilated. Be sure to make your measurements before, during, and after cooking so that you can make comparisons.

a. **Temperature:** Use a thermometer to measure how the temperature of the cooking space changes during cooking. This can help you figure out if the space is ventilated. If you don't have a thermometer, compare the feeling of the cooking space to another area of the building, or step outside. Is the cooking space warmer or cooler?
b. **Humidity:** Use a humidity monitor to measure how humidity changes during cooking. If you don't have a monitor, you can use a method called the dry and wet bulb thermometer test, which uses two glass thermometers. You can find more instructions in the StoryMap. If you don't have thermometers, you can place a paper towel, napkin, cloth, sponge, or another kind of **absorbent** piece of fabric or paper in the room where you are cooking. Observe how moist it feels before and after cooking, to compare how humidity changes during cooking.
c. **Smells:** Use a team member's sense of smell to observe how smells change during cooking. Move to other rooms to measure how far away you can still smell the cooking.
d. **Smoke:** Use a team member's sense of sight to observe how the smoke in the room changes during cooking. Does the cooking space become less clear? Or, if you have a smoke detector, does it sound an alarm during cooking? Do you see evidence of smoke from cooking in the past, such as streaks on the walls or ceiling?

Particulates Produced in Cooking Investigation

Particulates produce in cooking can be harmful to the health of people in the cooking area.

a. Use a monitor to measure how the concentration of particulates in the air changes during cooking.

b. Particle monitors can be expensive, so if you are unable borrow one you can use this simple observation instead. Place a light-colored piece of paper lined with double-sided tape, petroleum jelly, or another sticky substance in several parts of the cooking space. For example, place one near the cooking surface, one on the ceiling or wall, and one in the rooms closest and farthest from the cooking surface. Observe these papers before and after cooking for evidence of particulates. Compare the color of the sticky part to the non-sticky part of the light-colored paper.

Figure 3.2: This cooking fire has left dark particulates on the walls.

Gases Produced in Cooking Investigation

As you learned from Karuna, gases produced while cooking can be harmful to people.

a. Observe levels of carbon dioxide in a room by observing how stuffy it feels in a room before and after cooking starts.
b. If you have access to a monitor, you can use it to measure how the levels of different gases, such as carbon monoxide, sulfur dioxide, or nitrogen dioxide, change during cooking. Monitors that measure gases can be expensive, so ask a local university, laboratory, or engineering company if they have one your school could borrow.

Time Investigation

Use a watch, clock, or stopwatch to measure how long it takes to complete the cooking process. You can also measure how long it takes for the room to go back to normal—meaning there's no more evidence that cooking took place.

1. Read *At the Smithsonian*.

At the Smithsonian

Mauricio Rodriguez is a mechanical engineer and **design** manager in the Office of Planning, Design & Construction at the Smithsonian Institution. He explains how his team noticed a problem with ventilation at the National Museum of American History. Do you think this might be a problem in the spaces you investigated?

"At the National Museum of American History we had an issue with ventilation in the kitchens. The **exhaust** fans above the cooking surfaces were not strong enough to pull the greasy vapor all the way to the vent on the roof. All the greasy vapors were getting stuck inside the **ducts**. The grease started to drip back down and get on the chef's clothes. We immediately knew, 'Something is not working correctly here.' So we fixed it."

4. Gather as a team.
5. Share your data by creating a team chart with three columns. Title it "Cooking in my Community." Figure 3.3 shows an example. Label each column with these titles:
   a. "Who does the cooking?"
   b. "What source of energy is used?"
   c. "How does cooking affect the places in our community?"

Cooking in my Community

Who does the cooking?	What source of energy is used?	How does cooking affect the places in our community?
• *A 25-year-old man* • *A 75-year-old woman* • *A 50-year-old woman*	• *Firewood* • *Gas stove* • *Electricity from a coal power plant*	• *We saw smoke and noticed dark stuff on the sticky tape* • *It got much hotter during cooking and took a while to cool down after, so we don't think the kitchen has good ventilation* • *We noticed that it took less time to boil water when using an electric* ***induction stove*** *than a gas stove*

Figure 3.3: Example of a Cooking in my Community chart with data from several investigations.

6. Discuss these questions as a team and add the information to your chart.
    a. Who does the cooking in your community?
    b. What is the most common source of energy for cooking in your community?
    c. What effects from cooking did you observe?
    d. Did any of those effects worry you?
    e. Do you think any of those effects are unfair?
7. Keep your team chart. You will use it in the Act activity.
8. Read Karuna's ideas about who is affected by cooking in Nepal. Do you share any of these concerns in your own community?

Karuna Says . . .

In Nepal cooking is a woman's job. Women and children also collect the firewood. Going to the forest can sometimes be unsafe because of animals or accidents. And women are more vulnerable to accidents during cooking, like being burned. The entire process of collecting fuel and doing the cooking is what we call **drudgery**. In Nepal, women who are only 25 years old actually look like they are 50 years old because of the smoke from cooking and the effects of drudgery.

Act: *What about cooking in my community concerns me the most?*

In the Discover and Understand activities you collected data about cooking in your community. You learned what sources of energy people use, the effects of cooking, and why certain meals or ways of cooking are important to people. Why is this data important?

This data can help you identify what concerns you the most about the energy used for cooking in your community. Knowing what you are concerned about will help you decide what changes you want to make in your community. You will learn more about changes, solutions, and safer cooking for all in Task 2.

1. Gather as a team.
2. Break your team into three groups and have each group read one example from *Cooking Perspectives Examples*.
3. Take a piece of paper and divide it into four sections. Label each section with one perspective: **social**, **environmental**, **economic**, or **ethical**.
4. Review your *Perspectives Chart* from Part 2, Task 1 to help you remember some of the different perspectives about sustainable energy.
5. Read your assigned example by yourself and take notes for each perspective on your paper. Then share the perspectives you found with the rest of your group.

Cooking Perspectives Examples

In the Act activity, you need to think about what concerns you and what you would like to change in your community. It is important to include multiple perspectives when thinking about how to make changes in your community. Remember that you learned about social, environmental, economic, and ethical perspectives in Part 1. The examples listed here describe situations related to cooking that include one or more of those perspectives. As you read your assigned example, think about what concerns you and what perspectives you notice.

Example A

Electricity is very expensive in this community. Most people use natural gas or petroleum to cook because it is much cheaper than electricity. When used indoors, this can affect the air quality. A company in a nearby community can put up solar panels on people's houses. The electricity from solar panels is very cheap, but most people cannot afford to install them. It costs several months of pay to install the solar panels.

Example B

Children help collect firewood for cooking in this community. This means they have less time in a day to spend learning or playing with friends. Collecting firewood can sometimes involve walking long distances from home. Cooking in this community happens over a wood fire in the kitchen. This kind of fire can produce harmful particulates and gases. Usually women do most of the cooking. Because the women also take care of young children, the young children in this community are usually in the kitchen most of the day.

Example C

Most people in this community live in apartments that they rent and do not own. They are not allowed to make changes to their apartments and their landlords do not want to pay for improvements. Some apartments have electricity for cooking. Other apartments have coal stoves. Coal stoves can be bad for people's health. Some apartments have windows and fans that help bring fresh air into the kitchen and move harmful particulates and gases away from the people cooking. Other apartments have windows that do not open.

Remember to consider these two questions before you gather as a team: What concerns you? What perspectives did you notice?

6. Gather as a team.
7. Share your example with the team using these prompts:
    a. I was most concerned about _____ because _____.
    b. I noticed these perspectives: _____.

8. Think back to the activities from the Discover and Understand activities. Take out your *How We Cook* document from Discover. Take out your *Cooking in my Community* chart from Understand. You are going to think about what concerns you.
9. Think about these questions by yourself:
    a. What concerns you about who is doing the cooking in your community?
    b. What concerns you about the sources of energy your community uses for cooking?
        - Remember that you can use your *Energy Source Cards* from Part 2 for more information about each energy source.
        - If you found out something new about a certain source of energy, you can add that information to that *Energy Source Card*.
    c. What concerns you about the effects of cooking in your community?
    d. Think about the concerns and perspectives you identified when reading *Cooking Perspectives Examples*. Do you have any of the same concerns about your own community? Do you notice any of the same perspectives in your own community?
10. Choose what concerns you the most about cooking in your community. It could be who is doing the cooking, the source of energy, or an effect of cooking. Make this decision yourself.
11. Gather as a team.
12. Get a piece of paper and title it "Concerns List."
13. Ask each team member to share what concerns them the most about cooking in the community. Record these concerns on your *Concerns List*. You will need this in Task 2. Thinking about your concerns can be an important step in deciding what action you will take to make a situation better.

Task 2: How can we use sustainable energy to cook in the future?

In Task 1 you and your team investigated the effects on your community of the types of energy used for cooking and identified what concerned you the most. You also thought about how social, environmental, economic, and ethical perspectives influence the choices people make about the energy they use for cooking.
In this task you are going to think about how to make cooking in your community more sustainable. You will use a **survey** to ***discover*** what is most important to your community about cooking. You will ***understand*** how to make sustainable cooking choices by modeling two sustainable energy sources. Finally, you will ***act*** to decide how you can help your community use more sustainable energy sources for cooking.

Discover: *What matters the most to us about cooking?*

Before you can think about making changes, you need to know your community's cooking **priorities**, or what is most important to them about cooking. This will help you identify what people do *not* want to change and the perspectives that influence their choices. This information will help you create solutions that make sense for your community and will last a long time.

1. Get out your *How We Cook* document.
2. Discuss the following as a team:
    a. What was important to you about cooking your favorite meal and why?
    b. What do you want to keep the same about cooking that meal in the future? What would you want to change?
3. Create a new shared document called *Community Priorities*. Add your answers from Step 2 to this document.
4. Gather more information about your community's priorities using a survey. Read *Community Cooking Survey Instructions.*

Community Cooking Survey Instructions

Your team can collect information about your community's priorities by carrying out a survey.

Choosing People to Survey

a. It is normal to want to survey only the people you know well and feel comfortable with. But try to include people you may not know as well, or people who live in other parts of your community. This will help you get a more accurate picture of your community.
b. Think about the categories on your *Identity Map*. Use those categories to try to pick a diverse group of people to survey. For example, ask people of all different ages or of more than one gender.
c. You could also survey the people you observed cooking in the Cooking Investigation from Task 1, Understand.

Ways to Give a Survey

a. Talk to people in person.
b. Talk to people over the phone or through email.
c. Write down your questions on a paper and give it to people.
d. Design a survey on the Internet and send it to people.

Choosing What Questions to Ask

a. Decide what you want to ask in the survey. Some suggestions are included here:
   - What do you like about cooking?
   - What source of energy do you use to cook?
   - What might you want to change about cooking? For example, the cost of your source of energy, the time it takes, the effects on your health, or the effects on the planet.
   - What do you *not* want to change about cooking? For example, the social connection to others, traditions, or where you cook.

Figure 3.4: This food festival creates an opportunity for friends to gather together.

Tips for Giving a Survey

a. Make sure your questions are easy to understand.
b. Ask questions that have definite answers, such as, "What things do you like to do for fun?" instead of, "What do you like?"
c. Think back to Part 1, Task 2 when you made individual and team identity maps. Use these identity maps to help you think of what questions to ask.
d. Some people may feel more comfortable answering surveys if their answers are **anonymous**. Anonymous means people do not list their name.
e. Think about where you should give the survey. Is there a place in your community, either in person or online, where people gather and might be willing to answer your questions? Could you go from home to home? Would that be safe at this time?
f. Remember that you and your team members are part of your community. Think about what you already know about your community to help you choose the best way to get information. For example:

   - Will people in your community feel comfortable talking to a student?
   - Does everyone have access to the Internet if you want to do an online survey?

Safety Tips for Giving a Survey

Talk to your teacher for guidelines. They will know what is safest in your community.

⚠ Physical Safety Tip

Never go alone and always be aware of your surroundings. Pay attention to local guidance on whether it is safe to interact with people outside of your home.

⚠ Emotional Safety Tip

It can be hard to talk to other people in the community. You may feel shy or nervous. Someone may tell you they don't want to talk. That's okay! It doesn't have anything to do with you. It just means they don't want to share. You can show them respect by thanking them and moving on to another community member.

5. Carry out your Community Cooking Survey.
6. Gather as a team after you have completed your survey.
7. Assign one of the four perspectives to each team member. Remember that the perspectives are social, economic, environmental, and ethical. If you have more than four team members, it is okay if more than one person is assigned the same perspective.
8. Divide a class board or piece of paper into four sections and label each section with a perspective.
9. Review the answers from the survey on your own, thinking about when you notice the perspective you were assigned. Write down your thoughts in your perspective's section. Use the following questions to guide you:
    a. Social: What social perspectives are important to people? For example, being around loved ones, celebrating birthdays, or being a good host.

b. Environmental: What environmental perspectives are important to people? For example, the effects of cooking on a kitchen environment and the people in it, or the effects of certain energy sources on the planet.

c. Economic: What economic perspectives are important to people? For example, the cost of their current source of energy, the cost to change sources of energy, or the cost to make changes to the place where they cook.

d. Ethical: What ethical perspectives are important to people? For example, are people being harmed by cooking or unable to make changes because of money, laws, or social reasons?

10. Gather as a team again.
11. Add the information from your survey and Step 9 to the *Community Priorities* document. Now you have a record of what is important to people in your community.
12. Read Karuna's ideas about how social and economic perspectives affect the decisions people make about sustainable energy. Did anyone in your community have a similar perspective? Do you think money is a barrier for people making sustainable decisions?

Karuna Says . . .

The cleanest kind of cooking in Nepal is electric cooking. But if you want to switch to electric in Nepal, you will be spending money on an induction stove. Converting your house to an electric connection is another cost. Electric cooking is much cheaper over time, but it costs money up front.

Nepal does have 200 sunny days, so using solar stoves is possible, but people don't want to cook outside in the sun. Wood pellet stoves can burn as effectively as gas stoves. But in Nepal, we have to depend on India or China for the pellets. We don't have the technology to make the pellets here. People won't buy pellets because they have access to free firewood in the forest.

Clean technology is there, but social and economic perspectives prevent people from using those clean technologies.

Understand: *What are sustainable sources of energy for cooking?*

In the previous activity you and your team identified what is important to your community about cooking. This information can help you figure out what sustainable energy sources might work well in your community. In this activity your team will model two sustainable energy sources.

1. Gather with a partner or your whole team.
2. Read *Cooking with Biofuel Model* and *Cooking with Solar Stove Model*. Choose which activity you would like to do—or do both. You can divide the two modeling activities among your team members, if you prefer.

Cooking with Biofuel Model

Remember that biofuels are fuels that come from living things or things that were once living. Firewood, animal dung, fat, and crops like corn are examples of biofuels. You will use paper to model two types of biofuel in this activity.

a. Get out several sheets of scrap or new paper.
b. Place one sheet of paper by itself on a table. Place the other sheets next to it.
c. Gently crumple the single sheet of paper into a loose sphere or square shape. This is Biofuel A. Figure 3.5 has a photo of an example.
d. Pick up the other sheets of paper. Work as a team to try to combine as many sheets of paper as possible into a single shape that is the same shape and size as Biofuel A. You can tear, shred, fold, **compress**, roll, or do something else to the other sheets of paper to change their size and shape. This is Biofuel B. Figure 3.5 has a photo of an example.

Figure 3.5: Example of Biofuel A (left) and Biofuel B (right); Biofuel B is made out of several sheets of crumpled paper that have been compressed together.

e. Squeeze each biofuel model in your hands. Which biofuel **resists** being squeezed or compressed more? That biofuel is more dense. **Density** is a measure of how much mass there is within a specific volume. If you want, you can skip to Step f (under *Calculating Density*) now. Or you can calculate the density of your two biofuel models.

Calculating Density (Optional)

a. If you have a ruler, measure Biofuel A. Don't worry if your measurements aren't exact.

- If your crumpled paper is shaped like a rectangle or a square, measure the height, width, and length. Record these measurements.
- If your crumpled paper is shaped like a **sphere**, measure the **radius**. The radius is half the **diameter**. Record this measurement.

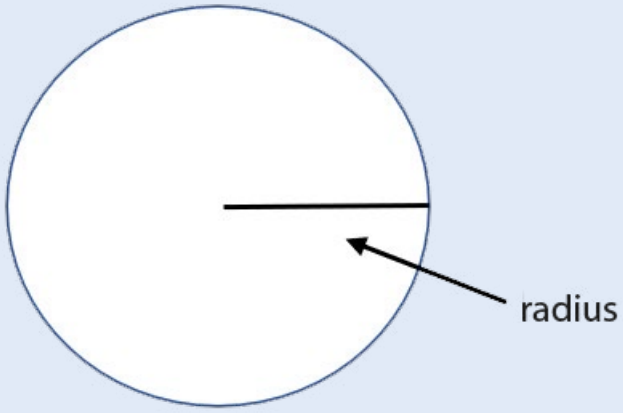

Figure 3.6: The radius of a circle; a slice through the center of a sphere is a circle.

b. If you have a ruler, measure Biofuel B. Don't worry if your measurements aren't exact. You just want the combined sheets of paper to be about the same size as Biofuel A.

   - If your paper is a rectangle or a square, measure the height, width, and length. Record these measurements.
   - If your paper is a sphere, measure the radius. The radius is half the diameter. Record this measurement.

c. If you have a scale that measures grams or ounces, measure the weight of Biofuel A and Biofuel B.

d. If you have measurements from both a ruler and scale, you can calculate the density of Biofuel A and Biofuel B.

   - First, calculate the volume of each biofuel.
     - If your biofuel is square or rectangle, the formula for volume is: Volume = length x width x height
     - If your biofuel is shaped like a sphere, the formula for volume is: Volume = 4/3 x π x radius^3 (π is a symbol called "**pi.**" Its value is 3.14, and is used to calculate the area of circles and the volume of spheres.)
   - Then, calculate the density.
     - Density = mass ÷ volume
     - You can use the values from Step c as the mass, even though you actually measured the weight.

e. Compare the density of Biofuel A to Biofuel B. Use these discussion questions:

   - Which biofuel is more dense?
   - Which biofuel do you think would burn longer?

f. Watch a demonstration of how the density of each biofuel model affects burning time in the StoryMap. Or, if your teacher or another adult is with you and gives permission, you and your team can light each of your models and observe how long each one burns.

⚠ Physical Safety Tip

Only burn the models if an adult is present and gives permission. Burn the models outdoors and one at a time. Burn them in a fireproof container, such as a deep metal can or bin. Have water, sand, or a fire extinguisher nearby.

Figure 3.7: Biofuel A (left) has completely burned and turned to ash. Biofuel B (right) is still burning.

These two models show the difference between firewood and wood pellets, both of which are biofuels.

Biofuel A is a model of firewood. Firewood is less dense than wood pellets. It produces more smoke, doesn't burn as long, and takes up more space than wood pellets. Firewood must be collected or cut down, and often it needs to be dried before being used. It is harder to transport from place to place because it is heavy and difficult to carry. In many cases women and children are responsible for collecting firewood. However, for many communities, firewood is cheap or even free to collect. Burning firewood can release a lot of carbon into the atmosphere that was previously stored in the wood.

Biofuel B is a model of wood pellets. Wood pellets are made of shredded wood that has been compressed into a smaller shape using a machine. Wood pellets are more dense than firewood. They produce less smoke, burn longer, and take up less space than firewood. Pellets are a safer and less harmful fuel for cooking. They are also easier to carry and move from place to place because they can be packed into bags. However, they must be produced by a special machine and sometimes

there are chemicals added to the pellets that can affect people around the places that produce the pellets. Pellets cost money to buy. Not every community has access to wood pellets. Burning wood pellets can release a lot of carbon into the atmosphere that was previously stored in the wood.

Figure 3.8: These biofuel pellets are made out of sawdust that has been compressed.

Cooking with a Solar Stove Model

A solar stove uses heat energy from the sun to cook food or heat water. A simple solar stove can reach temperatures of 150°C/300°F. It can be made with basic materials and can be used anywhere that the sun is shining for several hours a day. Unfortunately, solar stoves do not work well when the sun sets for the day or the sky becomes very cloudy.

You will model a very simple kind of solar stove in this activity.

a. Choose a sunny day with light wind or no wind for this activity.
b. Select a place that gets direct sunlight where you can put things on the ground or another flat surface.
c. Choose five pieces of a sturdy material such as cardboard or lightweight wood. They should all be about the same size.

d. Cover four of the pieces of sturdy material with tin foil, mirrors, or another kind of shiny and **reflective** material.
e. Cover one piece with a very dark material, such as black paper, black cloth, or dark dirt.
f. Place the piece covered with dark material on the ground in direct sunlight.
g. Arrange the other four pieces around the dark piece in the center. Angle each piece so it is tilted up toward the sun. You can use tape or another material to help connect the four pieces around the dark piece in the center.
h. Find a small glass or plastic container that you can use for the model. The container should be able to fit inside the model easily.
i. Place the plastic or glass container in the center of the dark part of the model. Make sure the container is placed face down or lid down so air cannot escape from the container. You have now built a simple solar stove.

Figure 3.9: A simple solar stove. This stove has three reflective sides. Your model will have four reflective sides.

⚠ Physical Safety Tip

The surface of the ground and the surface of the solar stove can become warm or hot. Do not touch the surfaces directly.

j. Find a substance that is solid at room temperature but melts when exposed to heat. You could use an ice cube, butter, ghee, coconut oil, or another substance. Place that substance inside the plastic or glass container, and make sure it's face down again.

k. If you have time, you can compare the temperature inside the solar stove to the temperature outside the stove.

- If you have a thermometer: Place the end of the thermometer underneath the plastic or glass container inside the solar stove. Observe and record the temperature. Remove the thermometer and place it outside the solar stove. Observe and record the temperature.
- If you do not have a thermometer: Place one piece of the substance from Step j inside a plastic or glass container inside the solar stove and another piece outside of the stove. Observe which substance melts more quickly.

This is a simple model of a solar stove. You can find instructions for a more complex solar stove in the StoryMap.

3. Gather as a team.
4. Together, discuss the following:
   a. Imagine you are the person in your community who is responsible for collecting and delivering biofuel to use for cooking. Which biofuel would you rather collect and deliver, firewood or wood pellets? Why?
   b. What communities do you think might be helped by a solar stove?
   c. Think back to your *Concerns List*. Are there any concerns that could be helped by using wood pellets or a solar stove? Why or why not?
5. Read Karuna's ideas about how to encourage people to switch to safer and more sustainable sources of energy for cooking.

Karuna Says . . .

We do something called a kitchen performance test to show people that electric cooking can cost less. We convinced one woman in a community to use an LPG cylinder for a whole day for cooking. It cost this person around 17 Nepalese rupees. The next day we asked her to cook all day with an electric induction stove. It cost her 9 Nepalese rupees.

Many of her neighbors came over to see the electric induction stove and were convinced to switch. Several households bought induction stoves, but so many people were using electricity that it broke the local **electric grid**! Our project worked *too* well. This is why Nepal needs to invest money in improving the electric grid.

Act: *How can I help my community make sustainable energy choices for cooking?*

In this part, you and your team have thought about why cooking is important to you. You have done a survey to find out what is important to your community. You have conducted investigations to find out the effects of the energy sources used in cooking. You have identified your community's concerns, what they want to change about cooking, and what they want to keep.

In this activity, you will use this information to help you add to your *Futures Mood Board* and come up with safer and more sustainable energy solutions for your community.

1. Get out your *Energy Source Cards*. Is there anything you have learned in this part that you would like to add to them? If so, add those details now.
2. Get out your *How We Cook* document from Task 1, Discover, your *Concerns List* from Task 1, Act, and your *Community Priorities* document from Task 2, Discover.
3. Review the information as a team. Remind yourselves of what your community thinks is important about cooking, what it is concerned about and wants to change, and what it wants to keep.

4. Get out your *Futures Mood Board*. Quickly review the **hopes** and concerns on the board.
5. Add any helpful information from Steps 1 and 2 to the *Futures Mood Board*. For example, you might want to add some of your community's concerns about the effects of cooking on their health. You might also want to add information about any cooking traditions they want to keep.
6. Read *At the Smithsonian*. How could you use some of the strategies described to improve the health of people in your community who do most of the cooking? Do you want to add any of these strategies to your *Futures Mood Board*?

At the Smithsonian

Hayes Robinson from Smithsonian Facilities solves problems that affect people's health. Hayes explains, "When we look at a certain process that harms someone's health, such as working with a dangerous chemical, we first ask, 'Can we stop using this chemical? If not, can we use something safer instead?' If we can't do that, we figure out if we can use an engineering control, such as an exhaust fan. If we can't use an engineering control, we will change the way we work with the chemical. Instead of working with the chemical for eight hours a day, we will only work with it for two hours. We use this strategy every day in **industrial hygiene**."

7. Recall that in Part 2 you arranged your *Energy Source Cards* in the order you thought they might be the most helpful to your community. You kept a record of the order.
8. Get out that record of the order of the *Energy Source Cards*. Discuss as a team:
   a. Do you still think this is the best order for the cards?
   b. Is it different when you are thinking about energy for cooking?
   c. How would you change the order after completing this part?
   d. How do these changes reflect the hopes and concerns of your community?

Congratulations!

You have finished Part 3.

Find out More!

For additional resources and activities, please visit the *Energy!* StoryMap at http://bit.ly/3Kx41Jy.

Glossary

This glossary can help you understand words you may not know. You can add drawings, your own definitions, or anything else that will help. Add other words to the glossary if you would like.

Absorbent: Able to take in a liquid substance, like water

Access: Able to reach a place, thing, or idea

Anonymous: People do not list their name

Carbon monoxide: A gas that can be harmful to people

Cataract: Cloudiness in the lens of an eye, which makes it difficult to see

Community: A group of people who share something in common, such as a space or an identity

Compress: To flatten or press together

Concern: Something that causes anxiousness, worry, or fear

Data: Facts and statistics that have been collected about a topic

Density: The measurement of how much mass per unit of volume a substance has

Design: Decide on the look and function of a building, space, process, or object

Diameter: The length of a line that passes through the center of a circle or sphere from one edge of the shape to the other

Drudgery: Work that is tiring or boring

Duct: A pipe or tube that helps move a substance from one place to another

Economic: Concerned with money, income, or the use of wealth

Electric grid: A network that connects producers of energy, such as power plants, with consumers of energy, such as homes or businesses

Energy: Anything that gives the ability to do work

Environmental: About the natural world

Ethical: The fairness of something

Exhaust: To remove gas or vapor from a space

Gas: A state of matter that expands to fill the space it is in, such as carbon dioxide

Hope: Something that is desired, wished for, or wanted

Hydropower: A renewable and low-carbon resource that converts energy from moving water into electricity

Identity: The characteristics that make you you

Induction stove: A method of cooking that uses electromagnetic energy to directly heat cooking vessels, such as pots

Industrial hygiene: A science that deals with protecting the health and well-being of people in their environment.

Inefficient: Something that wastes energy or time and does not complete the goal

Loose biomass: Materials from living things that are not tightly packed, such as dried animal dung (poop), maize (corn) stalks, rice straw, or small twigs and sticks

Liquified Petroleum Gas (LPG): An oil or petroleum energy source

Nitrogen dioxide: A gas that can be harmful to humans

Particulates: Small bits of matter floating in the air

Perspectives: The different ways we think about the world around us

Pi (π): A measurement used to calculate the area of circles and volume of spheres, usually represented by the π symbol; its value is 3.14

Power plant: A place where electricity is generated for many people

Priority: What is most important

Radius: The length of a line from the center of a circle or sphere to the edge of the shape

Reflective: A material that can reflect light, sound, or images

Resist: To push back against or withstand

Rural: A place with low housing density, such as the countryside

Social: The interaction of people in the community and their education, health, and well-being

Sphere: A round, solid figure, like a ball

Sulfur dioxide: A gas that can be harmful to humans

Surplus: Extra amount

Sustainable: An approach that balances different perspectives and can keep working for a long time

Survey: A list of simple questions you can ask a group of people

Tradition: Customs, beliefs, or practices within a culture or community that are passed from person to person

Ventilation: The circulation and exchange of fresh air within a space

