Smithsonian | SCIENCE *for Global Goals*

ENERGY!

How can we ensure sustainable energy for all?

SUSTAINABLE DEVELOPMENT GOALS

developed by
Smithsonian *Science Education Center*

in collaboration with
iap SCIENCE HEALTH POLICY
the interacademy partnership

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Energy!
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Community Research Guide

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Smithsonian Science Education Center

The Smithsonian Science Education Center (SSEC) is operated by the Smithsonian Institution to improve the teaching and learning of science for students in the United States and throughout the world. The SSEC disseminates information about exemplary teaching resources, develops curriculum materials, supports the professional growth of science teachers and school leaders, and conducts outreach programs of leadership development and technical assistance to help school districts implement inquiry-centered science programs. Its mission is to transform the teaching and learning of science in a world of unprecedented scientific and technological change.

Smithsonian Institution

The Smithsonian Institution was created by an Act of Congress in 1846 "for the increase and diffusion of knowledge . . ." This independent federal establishment is the world's largest museum, education, and research complex and is responsible for public and scholarly activities, exhibitions, and research projects nationwide and overseas. Among the objectives of the Smithsonian is the application of its unique resources to enhance elementary and secondary education.

Smithsonian Science for Global Goals (SSfGG) is a freely available curriculum developed by the Smithsonian Science Education Center (SSEC) in collaboration with the InterAcademy Partnership. It uses the United Nations Sustainable Development Goals (SDGs) as a framework to focus on sustainable actions that are student-defined and implemented.

Attempting to empower the next generation of decision-makers capable of making the right choices about the complex socio-scientific issues facing human society, SSfGG blends together previous practices in Inquiry-Based Science Education (IBSE), Social Studies Education (SSE), Global Citizenship Education (GCE), Social Emotional Learning (SEL), and Education for Sustainable Development (ESD).

Thank You for Your Assistance

Thank You for Your Support

This project was supported by General Motors through Grant #73409185 to the Smithsonian Science Education Center.

How can we ensure sustainable energy for all?

Part 1: Introduction to Energy	• Task 1: What is a sustainable energy future? • Task 2: How does my community use energy now?
Part 2: Sources of Energy	• Task 1: What do I know about energy sources on Earth? • Task 2: Which energy sources could help my community create a sustainable energy future?
Part 3: Energy and Cooking	• Task 1: How do we use energy to cook food in our community? • Task 2: How can we use sustainable energy to cook in the future?
Part 4: Energy in the Community	• Task 1: How is energy used in the spaces in our community? • Task 2: How can we use sustainable energy in our community?
Part 5: Using Energy to Get Around	• Task 1: How is energy used for transportation in our community? • Task 2: How can we make transportation more sustainable?

Part 6: Energy to Use and Make Things	• Task 1: How do we use energy to power things in our daily life?
	• Task 2: How can we make industry more sustainable?
Part 7: Taking Action	• Task 1: How will I help create a sustainable energy future?

Smithsonian
Science Education Center

Dear Parents, Caregivers, and Educators,

As a global community we face many challenges. At times, these worldwide problems can seem overwhelming. We may ask ourselves questions about how to understand these complex problems and whether there's anything we can do to make them better. This community response guide encourages young people to discover, understand, and act on the answers to these questions.

In the years leading up to 2015, people around the world worked together to share their ideas about how our world should be. These ideas became a list of goals, the United Nations Sustainable Development Goals. The goals represent a plan for a sustainable world: a world where peaceful societies collaborate; a world where we live in balance with the environment of our planet; a world in which our economies fulfill our needs; a world that is fair to all.

As youth around the globe engage with the activities in this guide, they will gain an understanding of the science that underlies the Sustainable Development Goals. They will be able to share their knowledge with their community, create tangible ways to help their community make informed decisions, and understand the best places to find additional information on these topics.

Throughout the guide, young people may find themselves asking many questions about pathways to a sustainable future. You do not need to have the answers to any of these questions. The most important thing you can offer young people is the opportunity to question, investigate, think critically and systemically, synthesize, and act. Ask the young people around you how they are feeling and what they are thinking about as they learn this content.

I am immensely grateful to the experts who helped to develop this guide—the InterAcademy Partnership, a collaboration of 140 national academies of sciences, engineering, and medicine; our colleagues across the Smithsonian Institution; and the external subject matter experts who contributed to this guide—for their perspectives and technical support in ensuring the science in this guide is accurate. I also want to say a special thank you to the developer of this guide, Logan Schmidt, for her thoughtful contributions to the *Smithsonian Science for Global Goals* project.

Working together—scientists, researchers, parents, caregivers, educators, youth—we can make a better world for all. This guide is a step toward that grand collaboration.

Thank you for partnering with us to inspire our youth to build a better world.

Best,

Carol L. O'Donnell

Dr. Carol O'Donnell, Director
Smithsonian Science Education Center

About this Community Research Guide

The goal of this guide is to prepare young people to take considered action on pressing global issues. Considered action means young people learn about a problem, connect it to the larger system, consider all the complexities of the problem, decide for themselves the best way to address it, and then execute a solution. Through this process young people are prepared not only to take considered action on a specific issue, but to build the skills needed to take action on all issues that affect them and their communities.

Figure 1: Sustainability Mindsets.

Learners use scientific and socio-scientific investigations to understand their local communities, scientific principles, and innovation possibilities. They then have a chance to immediately apply this information to make decisions that are informed by the results of their investigations. Along the way, young people are prompted to reflect, investigate, think critically, analyze, and build consensus. Engaging in these activities builds important skills of empowerment and agency, open-mindedness and reflection, equity and justice, and global-local interconnection. These sustainability mindsets prepare young people to take an active role in shaping the future of their communities and their world.

A Framework to Discover, Understand, and Act

Throughout the guide, young people are prompted to Discover, Understand, and Act. The three parts of their learning journey are described here.

Discover

Young people already have a lot of information and opinions about the world around them. In this guide, they are prompted to use that knowledge as an entry point. They will discover what they already know and what questions they might have. They are encouraged to consider different perspectives and priorities. This both empowers young people and provides an immediate relevance and context for their investigations.

Figure 2: Global Goals Action Progression.

Understand

Gathering new information is a primary goal of science. Using a wide variety of methods to do so helps young people understand the problems related to sustainable communities. They need to understand the problems both abstractly and within the context of their local community. Designing and conducting real-world investigations and interpreting results encourages young people to think like scientists.

Act

Finally, young people apply both their existing knowledge and their newly gathered information. First, they consider personal changes they could make to help make their communities more

sustainable. Then, as a team, young people find consensus on what they *could* do, what they *should* do, and what they *will* do. Teams then take action and reflect on the consequences, both intended and unintended.

Pedagogy Shift

This guide may feel like a big shift from the standard method of teaching. The guide is:

Led by Young People

To make progress toward a better world, we need the ideas, enthusiasm, and energy of every young person. We need them to help design and build the world in which they want to live. This means throughout the guide young people make authentic decisions about what and how they will learn. Their goal is to understand issues in their own community and take sustainable actions to make their community and their world better.

Driven by Data Collected by Young People

In this guide, the young people you teach will become action researchers. They will gather information about what sustainable communities mean in their own local spaces. This includes scientific investigations and experiments to understand the problems better, and also using social science methods to understand their community better. Using science and social science helps young people arrive at a sustainable solution.

Focused on Action

The goal of the guide is to help young people not just learn but also do. Throughout the guide young people will conduct investigations and then use that knowledge to make decisions about the actions that would be best for their community. They will then put those decisions into practice and see the results of their actions.

Customized for Local Communities

Each community is unique. While the world has global problems, the solutions must work locally. Young people already have tremendous knowledge about their local community. This guide prompts them to use that knowledge and find out new information to figure out solutions that are sustainable in *their* community.

Structure of this Community Research Guide

Parts

This guide is made up of seven parts. Each part works with the others to help learners understand how to help their community thrive and to put that knowledge to work by taking action.

However, we recognize that time is a limiting factor in many learning spaces. Therefore, the guide is designed flexibly so it can be shortened, if necessary. The learners are guided to do this shortening work themselves at the end of Part 1. The guide prompts learners to discuss with their teacher how much time is available and then make decisions about the best way to use that time.

Tasks

Within each part there are two tasks. Each task helps learners examine a different aspect of the topic they are exploring. Within each task, there are three activities, which correspond to the Discover, Understand, Act framework. Discover activities focus on existing learner knowledge. Understand

activities focus on gathering new information. Act activities focus on analyzing and applying that new information to make decisions. Tasks also include perspectives and stories from experts around the globe, so students can connect with the work of real-world scientists.

Using this Guide

Roles

The Learner's Role

Learners are the decision-makers of the guide. They will decide what information they need and what the information they gather means. Then learners use that information to decide and implement actions.

The Teacher's Role

This guide may be challenging for learners, since they may be unfamiliar with their role. Learners may need assistance in deciding what to do. Support and help them, but do not decide for them. Be patient. There are no right answers to the big questions posed by this guide.

Adapting the Guide for Your Context

Different Ages

This guide is designed to be used with young people between the ages of 8 and 17. This large range is deliberate to give access to these ideas to as many young people as possible. If you teach learners who are on the younger end of the age range you may need to support them a little more. For example, you might need to:

- Explain more complex words or topics
- Promote listening and tolerance in group discussions
- Support group decision-making
- Help them plan investigations in their community or accompany the teams on their investigations
- Help learners think through the feasibility of the action they plan
- Present alternate ways of capturing ideas; for example, if the guide suggests learners write, but that is too difficult or is inappropriate for your learners, they can always draw, act out, or just talk about their ideas

If you teach learners who are on the older end of the age range, the language of the guide might seem a little simple. However, older learners who can understand more complex ideas will be able to develop a more nuanced view of the problem and come up with more extensive solutions.

All young people should be able to engage with the guide in a way that is developmentally appropriate for them.

Different Resources

We have assumed you have very basic classroom resources, such as a class board (blackboard or whiteboard), paper, and pens or pencils. If it is not possible to capture learner writing, you can always have learners act out or discuss their ideas. If you do not have the capacity to print out a Community Research Guide for each learner, you or learner leaders can read the guide out loud from a single print or digital copy.

Accessibility

This guide is designed to be widely accessible. The language, tone, and format attempt to be as inclusive as possible to reach learners with a wide variety of learning styles. However, learners with specific needs may need teacher support. As mentioned earlier, the guide activities can always be adapted to fit learner abilities, either by you or by the students themselves.

Extensions

For each part and many tasks there are additional activities, videos, and resources available digitally. They can all be found at the *Energy!* StoryMap at http://bit.ly/3Kx41Jy.

Teams

Much of the research, decision-making, and action is designed to be done in teams. These teams can range in size from a group of two or three learners to the whole class. As a teacher, this is something to consider before beginning the Community Research Guide.

If you have motivated and responsible learners who need minimal teacher support, you may want to break your class into small teams. Smaller teams will allow individual learners to share their opinions and have more of an impact on team decision-making. With smaller teams, the experience can be more customized to the interests of the individual learner because there are fewer interests represented.

If you have learners who need more support, you may need to keep the class together in one team or have one team for each adult in the class. If you have only one team per adult, an adult can help support learners directly while they are engaging in activities such as conducting investigations and making decisions. However, because the team is larger, individual learners will have less of a voice in decision-making and less impact on group actions.

Alternately, if you have a group of learners with mixed abilities, you can design groups that bring together learners with different strengths. These types of groups can help learners support one another rather than immediately turning to an adult for support.

If you are uncertain whether a small or large group is most appropriate for your learners, you may want to wait and observe them during Task 1. In Task 1 in the Understand activity, learners break into groups and conduct investigations. If learners are able to complete this task independently with fairly limited teacher support, they would probably be successful in a small group. If learners need a great deal of help to complete this activity, you may want to structure group size so they can have more focused adult support throughout the Community Research Guide.

Getting Started

We recommend you give the young people you work with the Student Letter to read. You may also find it useful to read through each part of the Community Research Guide in its entirety before beginning that part. We suggest you encourage your learners to be excited about this new learning adventure. Be prepared to be enthusiastic about their ideas.

Student Letter

Dear Student,

This is the last time you will be called a student in this Community Research Guide. Instead, you will take on a new role as an action researcher. Action researchers are interested in figuring out what to do to make their communities better. They use scientific investigations to help understand the natural world around them. They use social science investigations to help understand the people, cultures, and history of their communities. Then they use the information they gather to help solve problems in their own communities. This guide will help you learn more about this process. The most important thing to know is that you will control your own research and make your own decisions.

Think back to a time when you solved a problem. You first needed to know what you wanted—your goal. Then you needed to figure out what you had to do to achieve your goal. This guide is similar. You will think about goals you have for your local community, then figure out what you need to take action to help reach those goals.

You and your classmates will work as a team to think about information you already have about the place where you live. Then you will investigate your local community and how things work. Finally, your team will decide how to make things better. Together, you will put your decision into action. Sometimes making decisions about what to do is difficult. Don't worry, this guide will give you lots of support.

How to Use this Guide

This guide is designed to help you explore and think about problems in your community. The guide is here to help you. That means you can always change it.

Adapting the Guide

You will notice that in this guide there are often suggestions about different ways of sharing your ideas or doing investigations. This is because different people think and work best in different ways. For example, some people like to draw, some people like to talk out loud, and some people prefer to write to express their ideas. This guide has suggestions, but you can always change the method suggested. You can share your

ideas using discussions, acting, signing, telling stories, recording your voice, writing by hand, typing on a computer, drawing, or another way you choose. Think about the way you and your team learn best together. Including everyone on the team is important.

Safety Tips

This guide asks you to do and think about things that may seem unfamiliar. You will notice physical and emotional safety tips in the guide. These will help you stay safe and supported during the activities. Make sure you follow your teacher's directions about staying safe.

Guide Structure

There are seven parts in this guide. Most parts have two tasks. Each task has three activities. The activities are called ***Discover***, ***Understand***, and ***Act***. In the ***Discover*** activities you will focus on thinking about information you and your team already know. In the ***Understand*** activities you will investigate to find out new information. In the ***Act*** activities you will put your existing and new knowledge into action by applying it and making decisions. Words that may be unfamiliar will be in **bold** the first time they are used. Then at the end of each part a glossary lists the definitions of these words.

Investigations

You are the one doing the research in this guide. This means often you will develop your own questions and determine the best way to answer them. Developing and answering questions is how scientists find out new information about the world around them. As an action researcher, you need to think like a scientist to discover what you need to know, investigate to find out more information, and think about the meaning of what you found out.

Keeping Organized

In this guide you will have some papers you will need to keep so you can look at them later. You may want to have a folder, notebook, or science journal to help you stay organized.

Teams

You will be working with other classmates as part of a research team. Your team will conduct investigations and make decisions together. When conducting research, there may be many things to figure out as a team. You will need to be creative. There will not always be a clear right and wrong answer. Sometimes the team might not agree. This is okay. Just make sure to respect your teammates. There is no one right answer to the problems faced by your community. There is just the right answer for you and your team.

Getting Started

You will be thinking about complex problems. Sometimes this can feel difficult. Be patient. You will be guided to consider different parts of the problem. By the time you are making big decisions, you should have lots of information. Always remember, your work is important. Decisions you make can change your community. You are an important part of making your local and global communities better.

Thank you for working to make your community better.

The Smithsonian Science for Global Goals team
Smithsonian Science Education Center
Smithsonian Institution

Smithsonian | SCIENCE *for Global Goals*

ENERGY!

Part 1: Introduction to Energy

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian *Science Education Center*

in collaboration with

iap SCIENCE HEALTH POLICY

the interacademy partnership

Smithsonian Science Education Center greatly appreciates the efforts of all the individuals listed below in the development of *Energy! How can we ensure sustainable energy for all?* Part 1. Each contributed his or her expertise to ensure this project is of the highest quality. For a full list of acknowledgments, please refer to the acknowledgments section at the beginning of this guide.

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PART 1: INTRODUCTION TO ENERGY

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: What is a sustainable energy future?					
Discover	Develop a personal *Identity Map* showing the different parts of who you are. Create a *Futures Mood Board* with your team's hopes and concerns for a sustainable energy future.	• Paper • Pens or pencils • Objects that represent you (optional) • Class board or poster paper • Photos or magazines (optional) • Art or craft materials (optional)		40 minutes	7
Understand	Conduct a survey of your community about their hopes and concerns about energy and the future.	• Paper • Pens or pencils		25 minutes + survey time	11
Act	Update your *Futures Mood Board* with information from your community survey.	• Paper • Pens or pencils	*Futures Mood Board*	15 minutes	16

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: How does my community use energy now?					
Discover	Conduct a Community Energy Observation to figure out your community's sources of energy and how energy is used.	• Paper • Pens or pencils		20 minutes + investigation time	18
Understand	Use your Community Energy Observation to evaluate the positive and negative effects of energy on your community.	• Large piece of paper • Pens or pencils		20 minutes + investigation time	21
Act	Continue building your vision for a sustainable energy future and decide which parts of the guide you will use.	• Paper • Pens or pencils	*Effects on Our Community* chart *Futures Mood Board*	20 minutes	23

Energy: How can we ensure sustainable energy for all?

People use **energy** every day to meet their needs. In this guide you will explore where your **community** gets energy, how it uses energy, and how you can ensure everyone in the community has access to the energy they need. You will investigate the effect energy use can have on the environment and how choices you and your community make can help or harm the environment.

While using the guide you will become an **action researcher** to identify and help solve problems in your community. Action researchers first ***discover*** their own existing knowledge, then they investigate to ***understand*** problems, and finally they ***act*** on what they have learned to make local and global communities better.

You will create and keep several sheets of paper or digital documents to help you record and remember information. You may want to use a notebook or folder to help organize the sheets you will use in the guide.

Remember: *In this guide you and your team are in charge. You can always change the instructions in the steps to make them work better for you and your team.*

Task 1: What is a sustainable energy future?

Who we are affects the way we think about and view the world around us. In this task you will first ***discover*** more about your own identity and perspectives about the future. Then you will ***understand*** more about energy and related knowledge and perspectives of your community. Finally, you will ***act*** to decide what you want to investigate and think about further.

Discover: *Who am I and what are my feelings about the future?*

Our different experiences, backgrounds, and ideas give each of us a unique identity. Your **identity** is what makes you you. Our different identities often lead to different **perspectives.** Perspectives are the different ways we think about the world around us. Understanding your own identity and perspectives can help you understand other people's perspectives.

1. Take out a piece of paper and title it "Identity Map." If you prefer, you can make an identity map using objects or digital tools. There are more details about how to do that in step 7.
2. Write your name in the center of the page or draw a small picture of yourself.
3. Draw a circle around your name or picture.
4. Think about your answer to the question, "Who am I?" The list below can give you some ideas to consider, but you choose what you want to include. You can also include things that are not on the list.
   - Age
   - School or class
   - Race and/or ethnicity
   - Gender
   - Country or place where you live
   - Country or place that is important to you or your family
   - Values or beliefs that are important to you
   - Goals that are important to you
   - Topics or subjects that interest you
   - Hobbies or things you like to do for fun

- Physical traits (such as tall, black hair, blue eyes, wears glasses)
- Personality traits (such as loud, funny, sad, kind)
- Roles you have in your household (such as big sister, helper, cousin)
- Groups you belong to

5. Write each answer on the page around your name.
6. Draw a line between your name and each answer. Figure 1.1 is an example of a written identity map. You can put your answers at the end of each line.

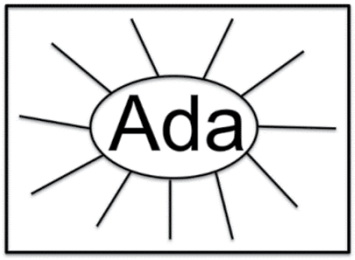

Figure 1.1: Example of a written identity map.

7. If you prefer, you can use objects around your home or classroom to create your map. To keep your map, you can take a picture of it or just remember it. Figure 1.2 is an example of an identity map using objects. You could also make a digital map using recordings or photos.

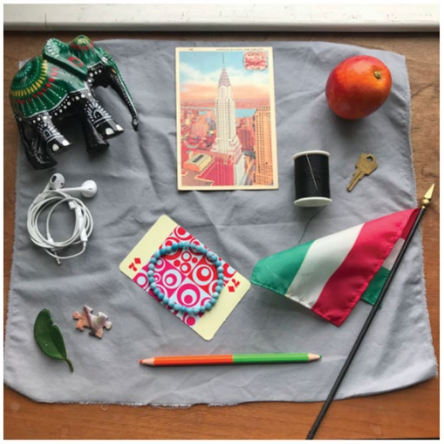

Figure 1.2: Example of an identity map using objects.

8. Form a team. Your team may be your whole class, or it may be a smaller group. Either is fine. As action researchers you will work together with your team, made up of your classmates, for the rest of this guide. You will work together to understand your local area and make it better.

9. Share your *Identity Map* with the members of your team.

> **⚠ Emotional Safety Tip**
>
> Sharing your identity with someone else can help build trust between you and that person. But it can be hard to share your personal identity with someone else. Only share parts of your *Identity Map* that you feel comfortable talking about.

10. Find any similarities to your *Identity Map*. For example, if you like to read for fun, see if you can find someone else in your team who likes to read for fun.
11. Find any differences from your *Identity Map*.
12. Think quietly to yourself about the similar and different identities you found in your team.
13. Consider those similarities and differences as you read *Our Identities, Our Perspectives, Our Future*.

Our Identities, Our Perspectives, Our Future

Different people may have different perspectives on what they want the future to be like. Sometimes these perspectives are related to identities or personal experiences. Our identities can affect what we know about or what we think is important. If there is something that is important to you now, you may want it to be part of your future. For example, maybe on your *Identity Map* you said you liked being outside. Then you might want easy access to the outdoors as part of your future.

In this guide you will be thinking about how to ensure a **sustainable** energy future for all. But first you must think about what a sustainable future is.

An approach that balances different perspectives and can keep working for a long time is called sustainable. A sustainable future balances **social, economic, environmental,** and **ethical** concerns in a way that works well for people and the planet.

- **Social** is about the interaction of people in a community. The health, education, cultural and community ties, and well-being of people are the most important things from this perspective.
- **Economic** is about money, income, and use of wealth. Economic growth, including making sure people have jobs and enough money, is the most important thing from this perspective.
- **Environmental** is about the natural world. Protecting living things, natural systems, and the Earth itself are the most important things from this perspective.
- **Ethical** means that something is fair. Doing what is right and having a just community where everyone and everything is treated fairly are the most important things from this perspective.

Your perspective about what a sustainable future should include is valuable. Other people may have different perspectives. Their perspectives are also valuable. Thinking about all these different perspectives together can help you envision a sustainable future that works for everyone, not just you.

14. Think quietly to yourself about how you would want the future to be different than life is now. Don't worry about thinking about energy yet. Just focus on what you want the future to be like in general. You can use your own original ideas or ideas from other places. Use ideas from your experiences, books, movies, or other media, or conversations you have had to help you think about these questions.
15. Label a large piece of paper or a shared digital document "Futures Mood Board." A **mood board** is a tool to help gather ideas, concepts, and styles to design something. In this case, you and your team are designing the future.
16. Divide the paper into two sections. Label one section **"Hopes"** and the other **"Concerns."**
17. In the *Hopes* section record your team's ideas by writing, drawing, or using digital images to represent your hopes for the future for you, your area, the people around you, and the whole world. A hope is something that is desired, wished for, or wanted. Do not feel like your ideas have to be possible today—dream big!

18. As you think about your team's hopes for a sustainable future, you may also start to think about things that concern you about the future. A concern is something that causes anxiousness, worry, or fear. Record these ideas in the *Concerns* section.

> **⚠ Emotional Safety Tip**
>
> When thinking about the future you might have many different feelings. It is okay to be worried or anxious. These feelings are natural, especially when the future feels uncertain. By thinking about your fears, you can prepare yourself and make choices to try to ensure a more hopeful future.

19. Examine your *Futures Mood Board* and discuss the following:
    a. Do you notice things that surprise you about the hopes and concerns of your other team members?
    b. Do you notice any hopes and concerns that you have in common?

> **⚠ Emotional Safety Tip**
>
> Sometimes you may want to keep hopes and concerns for the future private. Only share what you feel comfortable sharing.

Understand: *What does my community know and think about energy?*

You've just thought about your own perspective on a sustainable future. As an action researcher, one of your jobs is to find out more about what other people in your community know and think about energy now and in the future. A community is a group of people who share something—for example, your family, your classmates, your teachers, or your neighbors. A community can share space, like a local, national, or global community. Or a community can share an identity, like a religion, ethnicity, or common interest. If you think back to your identity map, you will probably realize you are part of many communities.

Understanding perspectives in your community is an important part of considering what is sustainable and what actions you want to take. Helping your community starts by considering who is in the community and how they feel. You can investigate this using a **survey**.

1. Read *What Is Energy?* and think quietly to yourself about the ways you interact with energy in your life right now.

What Is Energy?

What do you think of when you hear the word "energy"? You may think of the food you eat because it gives you energy to move, grow, and keep your body's systems running. Or you may think of your physical science classes and things like potential and kinetic energy. You may also think of turning the lights on in your classroom or home.

Energy is anything that gives the ability to do work. In this guide, you will specifically be exploring the ways people use energy to power the things and spaces we use in our daily lives, such as cooking, heating and cooling indoor spaces, transportation, and making and using products.

In this guide you will be thinking about how you can ensure a sustainable energy future in your community. You may want to start by asking people in your community general questions about energy now and in the future, to help you understand their perspectives, hopes, and concerns.

Figure 1.3: These people are using natural gas as a source of energy for cooking.

2. Consider which community's perspective on energy you would like to understand. Do you want to understand your school community? Your neighborhood? Your whole town? Discuss with your team.
3. Read the *Survey Instructions* for more information about how to give a survey and pick your questions.

Survey Instructions

You can use a survey to understand the people in your community better.
A survey is a list of simple questions you can ask a group of people.

Choosing People to Survey

a. Think about the categories in your *Identity Map*. Use those categories to try to pick a diverse group of people to survey, to get a more accurate idea of what your community thinks and feels. For example, you may want to survey people of many different ages or of more than one gender.

Ways You Could Give a Survey

a. Talk to people in person, on the phone, or using a virtual meeting.
b. Have people answer questions using paper, email, or an online survey.
c. Collect responses using a social media post.

Picking Questions

a. Consider open-ended or close-ended questions. An example of an open-ended question is, "What would be part of a sustainable energy future?" An example of a close-ended question is, "Is using more solar energy a part of a sustainable energy future?" You usually can get more information from an open-ended question, but if you have a lot of answers, it can be difficult to keep track of all the different ideas. Using a close-ended question is quicker, but you may miss some ideas from your community.
b. Try to make your questions neutral. That means you are not trying to put your opinion in the question. For example, imagine you were thinking about **power plants**, or places where electricity is generated for many people. "Do you agree that coal power plants are harmful to the planet?"

would not be a neutral question. The person answering the question might assume you want them to answer "yes." A more neutral question might be, "What do you think about using energy from coal power plants in our community?"

c. Write down any questions you might want to ask your community about their hopes and concerns for the future. For example:

   - How would you want the future to be different than life now?
   - Are there things you would like to remain the same?

d. You may also want to ask questions related specifically to energy. Write down any questions you might want to ask. For example:

   - Do you know where we get energy from in our community now?
   - What concerns you or frustrates you about the way we get and use energy in our community now?
   - Is there anything you wish we could do differently about getting and using energy in the future?
   - Is there anything that scares you about making changes to energy in our community?
   - Is there anything that makes you happy or excited about making changes to energy in our community?

Tips for giving a survey

a. Make sure your questions are easy to understand and specific, such as, "What worries you about the future?" instead of, "What worries you?"
b. Think about the best method for the survey. Is there a safe and easy way to gather the opinions of a wide variety of people in your community?
c. Think about the best way to survey your community. For example, does everyone have access to the Internet if you want to do an online survey?
d. Some people you survey may not be familiar with the meaning of energy. You may want to start off by sharing the definition of energy with them before you start asking questions. For example, you might say, "Energy is anything that makes it possible to do work. I'm trying to find out more about how our community uses energy to power the things and places we use in our daily lives."
e. Listen carefully when people are speaking.

Planning an Inclusive Investigation

a. Remember, including everyone is important. If you are working with a team, you may need to adjust the way you do your survey so that everyone feels safe, comfortable, and able to help. Those changes are okay! They are part of including everyone. Make sure to consider:

- Time: If the survey happens after school, does everyone in the team have time to do it?
- Comfort: If you decide to move around the community to do your survey, make sure everyone on your team feels safe and able to do this. If not, what is another way team members could help with the survey?
- Location: If the survey is going to happen in a specific place, how easy is it for team members to get to that place?

Safety Tips for Giving a Survey

Talk to your teacher or a trusted adult for guidelines. They will know what is safest in your community.

⚠ Physical Safety Tip

Never go out 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.

4. Examine the questions you listed and choose the questions you want to ask your community. You probably want to ask between five and ten questions in your survey. You may want a mix of close-ended and open-ended questions.
5. Decide on your survey methods and choose where, who, and how you will conduct your survey.
6. Assign different jobs to people. For example, if you decide to do an online survey, decide who will type the survey, who will share it, and who will collect the results.
7. Conduct your survey by yourself or with your team and record the results.

Act: *How can I help make a sustainable future for my local and global community?*

In the previous activities you examined your own and your community's hopes and concerns about energy now and in the future. Now you can apply what you have learned to think about the future your community wants and how that relates to a global future.

1. Take out your *Futures Mood Board* and compare it to the results of your survey. Are there hopes and concerns others in your community shared that are not yet part of your mood board? If so, add those ideas now.
2. With your team, use your *Futures Mood Board* to discuss important goals for a sustainable future. These goals might be based on your hopes, like "add more solar and wind power to our community," or they might be based on your concerns, like "make sure we don't have blackouts."
3. Read *The United Nations and the Sustainable Development Goals*.

The United Nations and the Sustainable Development Goals

Achieving a sustainable future like the one you just thought about is complex. It takes many people working together in many places to create a sustainable future. When many people are working together, it helps to have someone organizing. The **United Nations**, also called the UN, is a global organization designed to help governments and people around the world **collaborate**.

As the year 2015 approached, the UN asked countries and people around the world to imagine a better world and a better future. They worked together to determine a list of goals. Then the countries of the UN came to **consensus** on the most important goals needed to get to a better world. These goals for the global community are called the UN **Sustainable Development Goals**, or SDGs. The SDGs are the global goals designed by people across the world to work on from 2015 and 2030.

Figure 1.4: United Nations Sustainable Development Goals.

4. Examine the different SDGs. Are there SDGs you think are important for a sustainable energy future that your team didn't discuss? Do you think those goals are also important? If so, add those ideas to your *Futures Mood Board*.

Task 2: How does my community use energy now?

In the previous task, you began exploring what your community's sustainable energy future could be. Before you can take action on that vision, you need to know more about how your community uses energy now. In this task, you will ***discover*** the ways you and your community use energy. You will ***understand*** how using energy affects your community. Then you will ***act*** by using this information to continue developing your vision for a sustainable energy future.

Discover: *How can I find out more about energy use in my community?*

You and your community interact with energy every day. In this activity, you will use your senses to gather information about the sources of energy in your community, as well as how energy is used.

1. Read *Community Energy Observation* and carry out an observation of energy in your community.

Community Energy Observation

In this observation, you will observe energy in your community. This observation should include the sources of energy, how energy moves from place to place, and how it is used in your community. For example, you may observe how electricity is generated in power plants or through solar panels. You might also observe how energy is moved from one place to another through power lines or pipes. And you will likely have many opportunities to observe how people are using energy in activities such as driving vehicles, lighting homes or shops, cooking food, or using machinery. Or saving energy by doing things like turning off the lights.

Your observation will have four steps: observing with your senses, noticing what concerns you, noticing what makes you happy, and asking questions.

Directions

a. Decide if you will do this observation with a partner or with a group.
b. Choose an area to observe. It can be small, such as your classroom. Or you could observe a larger area such as your entire school, a street in your community, or your entire neighborhood.
c. Collect materials to help you record your observations, such as paper and a pencil.
d. Observe energy in your community with your senses and record what you observe. You can move around your community or find another way to explore it. You could explore your community through videos, photos, audio recordings, social media posts, or other records of your community spaces.

- What evidence of energy can you see?
  - For example, solar panels, power lines, lights, a person using a mobile phone
- What evidence of energy can you hear? If it helps, you can close your eyes during this observation.
  - For example, a power plant or a car engine
- What evidence of energy can you smell?
  - For example, the smoke from a cooking fire or exhaust from a car
- What evidence of energy can you feel or touch?
  - For example, the warmth of a heated room or the coolness of air condition

⚠ Physical Safety Tip

Do not use your sense of taste to try to observe energy. Do not touch forms of energy that you are unsure are safe to touch. For example, heat energy from the stove can burn and electrical energy from outlets can cause harm.

Figure 1.5: Power lines supply electricity to buildings in Hanoi, Vietnam.

e. Record your observations.
f. Add what concerns or worries you about what you have observed in your community. You might observe things such as noisy car engines, a strong smell from a power plant, or lights that are too bright or too dim at night.
g. Record what makes you happy about what you've observed in your community. For example, you might appreciate that energy makes it possible to take the bus, or that energy powers the mobile device you use to communicate with your friends.
h. Finally, record any questions you have about energy in your community. For example, you might be wondering, "Can businesses turn off their lights at night if no one is using the building?" or, "How can we make sure everyone who lives in my neighborhood has enough heat when it's cold?"

⚠ Emotional Safety Tip

Remember to be an inclusive team member. Every person on your team brings different skills and perspectives. Some members of your team may not want to or be able to use all of their senses. That is fine. Communicate with your teammates and find a way for everyone to participate and feel comfortable.

⚠ Physical Safety Tip

Never go out 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.

2. Keep the record of your observations in a safe place. You will need it in the next activity.

Understand: *How does energy affect my community?*

In the previous activity, you observed a variety of things about energy in your community: what it looks, sounds, smells, and feels like, what worries you, what makes you happy, and what questions you have. Now you will combine your observations with others in your class. You will identify the ways that energy affects your community.

1. Gather with your class.
2. Label a class board, a large piece of poster paper, or a shared digital document, "Effects on Our Community."
3. Draw an arrow at the top of the document. Label one end "Negative," the middle section "Not Sure," and the other end "Positive." Leave enough space below each label to record observations from you and your classmates.

Figure 1.6: Example of an Effects on Our Community chart.

4. Take out your observations from the Community Energy Observation in the Discover activity.
5. Add the information from your Community Energy Observation to the appropriate section of the *Effects on Our Community* chart. Some things you observed might have been negative, meaning they were harmful, unpleasant, or made things more difficult. Some things you observed might have been positive, meaning they were helpful, improved the community, or made things easier. If you weren't sure, record your information in the "Not Sure" section.
6. Give enough time for each person in the class to add to the *Effects on Our Community* chart.
7. As a class, consider the chart you have just created. Discuss the following:
   a. What effects do we want to know more about?
   b. How could we collect more information about these effects?

8. If time allows, use your answers to those questions to guide additional investigations into your community. Read the *Community Effects Investigations* for suggestions. If you do not have enough time for additional investigations, you can move on to the Act activity.

Community Effects Investigations

Generating energy, transmitting energy, and using energy can create effects such as noise pollution and air pollution. Collecting **data** about the effects of energy on your community can help you create a sustainable energy future for your community. Data helps identify problems, provide proof of those problems to the people in charge, and measure how things change over time.

The investigations described here are just two examples of data you can collect about the effects of energy on your community. You can also use online databases found in the *Energy!* StoryMap to investigate further. You will have the chance to do more investigations in later parts of this guide.

Noise Pollution

You may have noticed some noise in the Discover activity that affected your community in a negative way. If you have access to the Internet or a mobile device, there are websites and applications that can help you measure the precise loudness of the noise, usually in units called **decibels**. If you do not have access to the Internet, you can still collect data. Note what time the noise occurs, how often it occurs, how long it occurs, how loud it is compared to other sounds in the area, and how close the noise is to people.

Air Pollution

One of the major sources of air pollution is energy generation and use, such as coal power plants, burning biomass (such as wood), exhaust from vehicles, and heating devices. If you have access to the Internet or a mobile device, search for local air quality measurements. These measurements can tell you what types of particles are in the air and how concentrated they are. If you do not have access to the Internet, you can do a simple air quality investigation.

Cover both sides of a light-colored piece of paper with a clear, sticky substance, such as petroleum jelly. Hang or place the paper where you would like to investigate air quality. Leave it there for 24 hours or more. Then take down the paper and use a hand lens or microscope to examine it. You can observe how many particles were trapped by the sticky paper, and you may even be able to see what kind. Consider investigating several places in your community, both indoors and outdoors, such as kitchens, garages, parking lots, busy roads, or near factories and power plants. You can compare several locations to each other. Keep in mind that some of the particles on the paper may be from plants, such as pollen.

Figure 1.7: You might observe that some kinds of vehicles cause both noise and air pollution, like the exhaust from this gasoline-powered bus.

9. If you did any additional investigations, add the results of those investigations to your *Effects on Our Community* chart.
10. Keep the chart to use in the next activity.

Act: *What is my community's vision for a sustainable energy future?*

Remember that in Task 1 you created a *Futures Mood Board*. You recorded the hopes and concerns you and your community have about a sustainable energy future.

The data you just collected in the Task 2 Discover and Understand activities contain valuable information to add to your *Futures Mood Board*. In this task you will analyze the information from the Discover and Understand activities and continue developing your *Futures Mood Board*. This information helps illustrate what is happening now in your community so you can identify what you want to continue and what you want to change. The *Futures Mood Board* will help guide the rest of the work you do in this guide.

1. Consider the *Effects on Our Community* chart you made as a class.
2. Take out your *Futures Mood Board*.
3. Add information from the *Effects on Our Community* chart to your *Futures Mood Board*. Use the questions below to help guide you:
   a. What positive effects on your community might you want to continue? Consider adding those to *Hopes*.
   b. What negative effects on your community are you worried about? Consider adding those to *Concerns*.
   c. What about the effects you marked as *Not Sure*? Is there anything you want to make sure you learn more about as you complete this guide?
4. To help you select the parts of the guide that could most help you ensure a sustainable energy future for your community, reflect on the following questions by yourself:
   a. What part of the *Futures Mood Board* matters the most to me?
   b. What part of the *Futures Mood Board* do I think matters the most to my community?
   c. What part of the *Futures Mood Board* do I think matters the most to the world?
5. Compare your answers with those of the other members of your team.
6. Read *Picking a Path*.

Picking a Path

You and your team must complete Part 2 before moving on to the other parts in this guide. Part 2 is about sources of energy. In this part you will explore the many sources of energy on Earth.

After your finish Part 2, you can choose which parts to complete based on what works best for you and your team. For example, if you are interested in energy and cooking, you might choose to complete Part 3. Or you may have enough time to do Parts 3 through 6. Everyone should also complete Part 7 which helps you choose and implement your action.

Parts 3 through 6 are about:

Part 3: Energy and Cooking: Examining the sources of energy people use for cooking food and how it affects health and safety

Part 4: Energy in the Community: Exploring the ways people use energy to heat, cool, and light their homes and places they use in the community

Part 5: Using Energy to Get Around: The kinds of energy used to move people and things both short and long distances

Part 6: Energy to Use and Make Things: Exploring the products that use energy and how people use energy to make things, grow things, and break things down

7. Figure out how much time you have to complete the parts of this guide. For example, your teacher may say you only have time to do one part, just a few parts, or maybe all of them.
8. If you do not have time for all the parts, discuss with your team and pick the parts that are most closely related to the hopes or concerns from your *Futures Mood Board*.

Congratulations!

You have finished Part 1.

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.

Action researcher: A person who works with their community to discover, understand, and act on local and global problems they learn about

Collaborate: To work together on an activity or toward a goal

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

Concern: Something that causes anxiousness, worry, or fear

Consensus: A balanced decision that works for everyone in the group

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

Decibel: A measurement of how loud a sound is

Economic: About money, income, and the use of wealth

Energy: Anything that gives the ability to do work

Environmental: About the natural world

Ethical: Something that is fair

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

Identity: The characteristics that make you you

Mood board: A tool to help gather ideas, concepts, and styles to design something

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

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

Social: Relating to the interaction of people in a community

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

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

Sustainable Development Goals (SDGs): Seventeen goals for a better world created by the countries of the United Nations

United Nations: A global organization designed to help governments and people around the world collaborate

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SCIENCE
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ENERGY!

Part 2:

Sources of Energy

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian
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in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

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PART 2: SOURCES OF ENERGY

Find out More!

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

Part 2

Planner

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 1: What do I know about energy sources on Earth?					
Discover	Make *Energy Source Cards* with information, thoughts and feelings about sources of energy on Earth.	• Paper, cardstock, or another durable material • Pens or pencils • Art or craft materials (optional)		15 minutes	35
Understand	Create a *Perspectives Chart* to organize important characteristics of energy sources on Earth.	• Paper • Pens or pencils	*Energy Source Cards*	25 minutes	38
Act	Decide what is most important about energy sources for your community, and create a *Sustainable Energy Statement*.	• Paper • Pens or pencils	*Futures Mood Board* *Effects on Our Community* chart *Perspectives Chart*	20 minutes	40

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: Which energy sources could help my community create a sustainable energy future?					
Discover	Add social, environmental, economic, and ethical perspective characteristics to your *Energy Source Cards*.	• Paper • Pens or pencils	*Sustainable Energy Statement* *Energy Source Cards*	25 minutes	42
Understand	Research the benefits and concerns of each source of energy on Earth.	• Pens or pencils • Computer or other research tools (optional) • Art or craft materials (optional)	Community Energy Observation Community Effects Investigations Part 1 Survey results *Energy Source Cards*	20 minutes	47
Act	Arrange your *Energy Source Cards* to show which would be best at meeting the needs of your community.	• Pens or pencils • Art or craft materials (optional)	*Futures Mood Board* *Energy Source Cards*	10 minutes	50

Meet Your Research Mentor

Meet Dr. Arielle Miller. Arielle (pronounced *AIR-ee-el*) will be your research mentor to help you understand more about nuclear power and **sustainable** sources of **energy**.

Arielle is a professional nuclear **engineer**, PhD coach, educator, consultant, and former nuclear-trained surface warfare officer in the United States Navy. She has a master's degree in nuclear engineering and a PhD in mechanical engineering. However, she also has knowledge and **perspectives** that came from other parts of her **identity**. Since Arielle is now working with you, it is important to understand who she is.

Arielle's Identity Map

Female

41 years old

Black

Jewish, Italian, and multi-racial

Lives in Washington, D.C.

Interested in space and nuclear engineering and power

Like reading science-fiction and fantasy books

Is a dog mom

Enjoys watching streaming shows

Enjoys cooking

Likes trying to keep her plants alive

Likes working on her car and her house

Wears glasses

Has curly brown hair

"I embrace challenges and pushing myself."

"I love helping other people in the STEM community."

" I can be extroverted in public but need time to myself."

"I'm very organized and like to have a plan and a routine. "

Task 1: What do I know about energy sources on Earth?

You probably use energy to meet your needs every day. You might light a fire for cooking, turn on a lamp, get on a bus, or charge an electronic device like a mobile phone. Where does that energy come from?

In this task you will ***discover*** what you and your team already know, think, and feel about energy sources on Earth. You will analyze different perspectives to ***understand*** characteristics of energy sources. Finally, you will ***act*** to share what you think about **sustainable energy** with someone else.

Before you begin Part 2, think quietly to yourself about Arielle's identity map.

- Are there things you have in common with Arielle?
- Are there ways in which you are different from Arielle?
- Can you see anything about Arielle's identity that helps her understand different perspectives or ideas about sustainable energy?

Throughout Part 2 you will notice Arielle 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. If she uses words you don't understand, you can use the glossary to help you.

Discover: *What do I know, think, and feel about energy sources on Earth?*

You might already know about one of the biggest sources of energy on Earth: the sun. Certain living things on Earth are able to absorb sunlight and convert it into **chemical energy** that they and other living things can use. Plants, algae, and certain kinds of bacteria are some of the living things that can use sunlight for energy.

Apart from sunlight, there are several other sources of energy on Earth. This activity will help you explore what you already know about these sources.

1. With your team, discuss: What are the sources of energy we can think of?
2. Work with your team to create a set of nine cards. These *Energy Source Cards* will help you collect and organize information about different sources of energy as you use this guide.
    a. Create the cards from a sturdy material that you can keep safe and add to as you complete more parts of the guide, such as paper, cardstock, poster paper, or cardboard.
    b. Leave plenty of room on each card to add more information later. Consider using a half or full sheet of paper for each card.
3. Read *Sources of Energy on Earth*. Divide up the blank cards among your team and write the name of one type of energy source on the top of each card. Underneath, add the description of the energy source.

Sources of Energy on Earth

People use the following sources of energy to help them meet their needs:

- **Solar energy:** converts light energy from the sun into electricity using solar panels
- **Wind energy:** converts wind, or the movement of air, into electricity using a wind **turbine**
- **Hydropower and ocean energy:** converts energy from moving water, such as a river or the tides of the ocean, into electricity
- **Nuclear energy:** converts the energy created by breaking apart the center of **atoms** in **uranium** into electricity
- **Biofuel energy:** uses the energy found in living things, such as wood, algae, or animal poop, to generate electricity or produce heat
- **Geothermal energy:** uses heat from underground to produce electricity or heat
- **Petroleum (also called oil):** a liquid made of fossilized living things that were buried millions of years ago; it can be burned to generate electricity or provide heat
- **Coal:** a solid made of fossilized living things that were buried millions of years ago; it can be burned to generate electricity or provide heat
- **Natural gas:** a gas formed from living things that were buried millions of years ago; it can be burned to generate electricity or provide heat

If any of these sources are not familiar to you, don't worry. You will learn more about them later.

4. With your team, sort your *Energy Source Cards*. If you are familiar with a source of energy, place it in one pile. If you are not, place it in another pile.
5. Discuss with your team:
    a. Are there any energy sources that everyone is familiar with?
    b. Are there any energy sources only some people know about? If so, have them share what they know with the rest of the team.
6. Using the pile of *Energy Source Cards* you know, work with your team to sort them into three piles:
    a. In the first pile, place any energy sources you think have a positive effect on people and the environment.
    b. In the second pile, place any energy sources you are unsure about or you think might have a mixed effect.
    c. In the third pile, place any energy sources you think have a negative effect.
7. Discuss with your team:
    a. Does anyone disagree? Have each teammate share why and pay close attention.
8. Turn to a partner and share how you feel about each source of energy. Pay attention as they share their feelings with you.
9. Come back together as a team. On each *Energy Source Card* write "feelings." Next to it, write any feelings team members had about that energy source that they want to remember.
10. As a team, try to place your *Energy Source Cards* in order from the energy source you think is used the most often in your **community** to the energy source that is used the least. If you disagree, keep discussing your ideas until you can come to **consensus**.
11. On each card write "community energy use:" Then write the number showing the order in which you placed your cards. Write "1" for the energy source used most often and "9" for the one used least often. Write the other numbers that show the rest of the rankings.
12. Discuss with your team:
    a. Which energy sources do you think you need to learn more about?
    b. Which energy sources are you most worried about? Why?
    c. What surprised you about your team's answers?
    d. What question did you disagree on the most?

Understand: *What are some different perspectives related to energy sources?*

In the Discover activity, you might have realized that you already know a lot about some energy sources. Others might have been totally new to you. To help your team and your community create a more sustainable energy future, it's important to learn about all the energy sources on Earth and things to consider when using them.

1. Divide your team into four groups and assign each group one perspective: **social**, **environmental**, **economic**, or **ethical**.
2. With your group, discuss questions you think are important to consider about different energy sources from that perspective. For example:
    a. Social: How is energy used by people to help with social interactions, education, and health? Are there things in our culture that make us want to use certain types of energy? Is this energy reliable? Can we count on it when we need it, such as keeping power on in a hospital?
    b. Environmental: What are the ways using different energy sources can affect the environment? Be sure to consider the local environment, like noise, smoke, or changing land or waterways. Also consider the global environment, such as releasing gases into the atmosphere.
    c. Economic: Is the source of energy expensive or affordable? Do many people in your community have jobs related to one type of energy? Does it cost a lot of money to build the **infrastructure**, such as a dam or **power plant**, for the energy source?
    d. Ethical: How fair is the use of energy? Are there dangers? Are some people or other living things more at risk than others? Does everyone have access to energy?
3. Take a large piece of paper or a class board and divide it into four sections. Label each section with one of the perspectives. Title the paper "Perspectives Chart."
4. With your group use the perspective section you were assigned and add the characteristics of energy you discussed related to that perspective.
5. As a team, examine all the sections in your *Perspectives Chart*. If you can think of anything that is missing, add it now.
6. Read *Energy and the Global Environment*. Add anything you think is important from this list to your *Perspectives Chart*.

Energy and the Global Environment

The relationship between energy and the global environment can be complex. There are different ways to describe this relationship, and you may not be familiar with all of them.

Renewable and Non-Renewable Energy

Renewable and **non-renewable** describe the type of materials used as energy sources.

- Renewable: Energy sources that are not likely to run out for a very long time or that are replaced faster than they are used. An example is solar energy. The life span of the sun is much, much longer than a person's life span and the sun **emits** far more energy than people can use.
- Non-renewable: Energy sources that run out faster than they can be replaced. A common non-renewable energy source is **fossil fuels.** A fossil fuel is an energy source that formed millions of years ago from living things that died and were buried under deep layers of **sediment**. One example is coal. It takes millions of years for coal to form and it cannot be replaced in a person's life span. Other examples of fossil fuels include natural gas, and petroleum (oil).

Figure 2.1: Coal is formed when layers of earth are compressed. *Coal mine tunnels like this one allow people to* access *the layers of earth that contain coal.*

Greenhouse Gases

Another way to think about the effect of energy sources on the global environment is to consider **greenhouse gases**. Greenhouse gases are gases such as carbon dioxide or methane that cause the atmosphere to get warmer.

- **Low-carbon or zero-carbon:** An energy source that releases very little or no carbon dioxide gas into the atmosphere.
- **High-carbon:** An energy source that releases a lot of carbon dioxide gas into the atmosphere. Fossil fuels are one example of a high-carbon energy source.

7. Read Arielle's ideas about nuclear energy. She is telling you that nuclear energy is not renewable but it is low-carbon to zero-carbon. Are there any other sources of energy you can think of that are also low- to zero-carbon?

Arielle Says . . .

I would classify commercial nuclear power plants as low- to zero-carbon, because carbon dioxide is not emitted by nuclear power plants.

Currently nuclear power is not renewable. As long as we are continuing to mine for uranium instead of using the fuel we have left over, nuclear is not going to be renewable. We will still be creating an unnecessary impact on the environment because uranium mining is no different than any other type of mining. It's incredibly harsh to the environment.

8. Keep your *Perspectives Chart* to refer back to in the Act activity.

Act: *What are the characteristics of sustainable energy?*

You and your team have gathered information about energy sources and perspectives. Now you will decide what is most important about energy sources for your community.

1. By yourself, think about the perspectives on energy that you believe matter most to your community. You can use:
    a. Your *Futures Mood Board*. What are your community's **hopes** and **concerns** about the future?
    b. The results from your **survey** from the Part 1, Task 1, Understand activity. What seemed important to the people in your community?
    c. Your class's observations from the *Effects on Our Community* chart in Part 1, Task 2, Understand. What did you notice that made you worried? Happy?
2. Take out your *Perspectives Chart*. Is there anything important to your community that is not listed? If so, add it now under the appropriate perspective.
3. Within each perspective section, have each person on your team make a mark, such as a checkmark or a plus sign, next to the three things they think are most important.
4. After your team has finished, examine each perspective section. Circle the three characteristics from each perspective that have the most marks next to them.
5. With your team, take out a piece of paper and title it "Sustainable Energy Statement." Then write, "We think sustainable energy needs to be . . ." Then fill in the rest of the statement using the circled items on your *Perspectives Chart*. Remember, sustainable requires balancing the four perspectives. Sustainable energy is energy that can help people meet their needs now without harming or risking the future of the next generation.
6. Read over your *Sustainable Energy Statement*. Is everyone on the team comfortable with it?
7. Have each team member share your *Sustainable Energy Statement* with a friend or family member. Do they agree or do they have new ideas they want to add to the statement?
8. Bring those ideas back to your team and pay attention to any ideas your teammates gathered. Is there anything you want to add to your statement to help you remember important ideas from your community?
9. Keep your *Sustainable Energy Statement*. You will need it in the next task.

Task 2: Which energy sources could help my community create a sustainable energy future?

You and your team are using this guide to help you create a more sustainable energy future for your community. Part of that work involves choosing sources of energy that help your community achieve that future. But how can you make the right choices for your community?

In this task you will ***discover*** how to analyze different energy sources from different perspectives. You will gather information to ***understand*** more about each source. Finally, you will ***act*** to rank which energy sources seem to support the sustainable energy future you've imagined for your community.

Discover: *What are the characteristics of different energy sources?*

Think about the last time you remember someone discussing a source of energy. What kinds of words or did they use? They may have used words like "sustainable," "renewable," "clean," or "affordable." Experts sometimes use words like these to describe the characteristics of energy sources.

But remember that *you* are an expert in your community. You can describe energy sources using the characteristics you think are most important. Doing this can help you figure out which energy sources are the right fit for your community's sustainable energy future.

1. Take out your *Sustainable Energy Statement* and your *Energy Source Cards*.
2. Pull out the Nuclear Energy *Energy Source Card*. You will do this exercise together as a team as an example.
3. Write "social," "environmental," "economic," and "ethical" on the Nuclear Energy card.
4. Reread your *Sustainable Energy Statement* to help remind you of the most important parts of the different perspectives on energy.
5. Read *Characteristics of Nuclear Energy*. Pay close attention to the perspectives you notice.

Characteristics of Nuclear Energy

Nuclear energy is a low-carbon resource. It is not considered renewable because it uses a certain kind of metal, uranium, that cannot be replaced. Nuclear power plants don't take up very much space but they produce a lot of electricity. They are reliable, meaning they produce energy 24 hours a day. Nuclear power plants are expensive and can take a long time to build. If nuclear power plants leak their materials, it can have very serious and dangerous effects on the living things in the community. This has happened a few times in the past, and people and other living things in the area around the nuclear plants have died or were harmed in other ways.

6. Write the characteristics you notice about nuclear energy next to each perspective on your Nuclear Energy *Energy Source Card*. For example, based on the *Characteristics of Nuclear Energy* you might write:
    a. Social: reliable energy
    b. Environmental: low-carbon, not renewable, uranium mining, doesn't take a lot of space
    c. Economic: expensive to build
    d. Ethical: can be dangerous to people and other living things nearby if it leaks
7. Divide the remaining eight *Energy Source Cards* up among your team. It is okay if one person has more than one card. It is also okay if several people have one card.
8. On each *Energy Source Card* write "social," "environmental," "economic," and "ethical."
9. Read *Characteristics of Energy Sources* to find out more about the energy source on your card.

Characteristics of Energy Sources

Solar Energy

Solar energy is renewable and low-carbon. Solar energy is most useful in parts of the world that get lots of sun, like countries near the **equator**. Solar panels can be expensive to install but can generate low-cost electricity, as long as the sun is shining. They can be installed in many kinds of spaces, such as in deserts or open

fields or on top of houses and other buildings. Sometimes the panels need large amounts of space to generate enough electricity for a community. This can take away space from other living things in the area. Solar panels are built with special minerals. Sometimes mining these minerals can cause harm to the people and communities that work or live near the mine.

Wind Energy

Wind energy is renewable and low-carbon. Wind energy is best used in places that get steady and continuous wind throughout the year. Wind energy can be expensive to install but can generate low-cost electricity, as long as the wind is blowing. Some people do not like the way wind turbines look, the noise they make, or their large size, and don't want them near their communities.

Hydropower and Ocean Energy

Hydropower is renewable and low-carbon. As long as water is flowing, hydropower plants can generate electricity. Hydropower can be used in places with moving water, such as rivers or oceans. Some hydropower plants use a dam to control the flow of water. Those dams can cause harm to the living things in the water or to the people in the communities nearby. Dams can also be expensive to build, although once they are built they can generate electricity for a long time.

Biofuel Energy

Biofuel is a renewable resource. It comes from living things (or things that were once living), such as wood, algae, corn, or animal poop or fat. Biofuels are usually burned to generate heat or electricity. Burning biofuels produces carbon dioxide, but less than when you burn fossil fuels. Biofuels can be burned any time of day. Sometimes waste products are used for biofuel, which captures energy from something that otherwise would be discarded. Other times plants are grown to use as biofuels. Growing plants for biofuels can take up a lot of space and involve using water, fertilizers, and machinery that can have negative affects on the environment. When biofuel crops compete with food crops for space, it can make the cost of food go up. Biofuels can be transported from one place to another.

Geothermal Energy

Geothermal energy is a renewable and low-carbon resource. It uses heat from under Earth's surface to produce electricity or to heat water for cooking or cleaning. Places with a lot of **geologic activity**, such as places with volcanoes or earthquakes, can use geothermal energy to power an entire community. But it can also be used in places with little geological activity to power smaller areas like a house or building. Geothermal energy is constant, meaning it is always available. Geothermal energy can be expensive to build, especially if you want to use it in a single home or building. But, like solar and wind, the cost over a long period of time is very small.

Oil or Petroleum

Oil is a fossil fuel, is not low-carbon, and is non-renewable. Oil is a liquid that forms when living things die, are covered in layers of dirt and rock, and are compressed. Burning oil can generate heat and electricity. Oil can also be changed into other products, like gasoline. Oil produces a lot of carbon dioxide. It can be less expensive than some other energy sources. It can be transported from one place to another and can be burned any time of day. Getting oil out of the ground can harm the people or other living things nearby. When oil leaks into the environment it can have very serious and dangerous effects on the living things in the community.

Figure 2.2: This oil pipeline passes very close to a national wildlife refuge.

Coal

Coal is a fossil fuel, is not low-carbon, and is non-renewable. Coal is a solid that forms when living things die, are covered in layers of dirt and rock, and are compressed. Burning coal can generate heat and electricity. Burning coal produces a lot of carbon dioxide. Removing coal from the ground disturbs and harms the living things nearby and can be dangerous for the people doing the mining. Coal can be less expensive than some other energy sources. It can be transported from one place to another and can be burned any time of day.

Natural Gas

Natural gas is a fossil fuel, is not low-carbon, and is non-renewable. Natural gas is a gas that forms when living things die, are covered in layers of dirt and rock, and are compressed. Burning natural gas can generate heat and electricity. Burning natural gas produces a lot of carbon dioxide, though not as much as coal. It can be less expensive than other energy sources. It can be transported from one place to another and can be burned any time of day. Getting natural gas out of the ground can sometimes harm the people and other living things nearby. It burns very easily, and can be dangerous if it leaks from where it is stored.

10. Fill in each of the perspectives for your *Energy Source Card* or cards, just as you did for nuclear energy.
11. Form a circle and pass the cards around the circle. Read each card before you pass it along to the next person.
12. Discuss with your team:
    a. Which perspectives are easiest to understand?
    b. What information do you think is missing?

Understand: *How can we learn more about the characteristics of energy sources?*

In the previous activity you and your team started to think about the characteristics of energy sources, based on a brief description. But you have access to more **data** than just this guide. In this activity you will research more about the different energy sources.

1. Take out your Nuclear Energy *Energy Source Card*. Write "Benefits" and "Concerns" on the card.
2. Think about any additional questions you have about nuclear energy. How could you answer those questions?
3. One way to answer questions is to ask an expert. Read Arielle's two quotes. Add any information you learn from Arielle to the *Benefits* and *Concerns* on your card. Use other information on your card to write any additional benefits or concerns.

Arielle Says . . .

One of the big criticisms I have about nuclear power is the people developing it didn't think about the waste at first. They kept saying, "We'll worry about it later; it will be tomorrow's problem." Well, eventually tomorrow came. The waste became this big problem that nobody wanted! We have to think about how to handle nuclear waste *now,* because the cheapest, cleanest, easiest way to solve these issues is now, not later.

It's not just the waste. Getting more fuel for **nuclear reactors** also has an effect. When you ask where we're going to get more uranium, you hear, "Oh well, we'll just go **mine** for more." Okay, well that's going to impact a community. There is currently only one active uranium mine in the United States. Most uranium mines are in Kazakhstan, Canada, and Namibia. There are a lot of environmental, social, and ethical issues with mining uranium. We should focus on finding a way to use the nuclear waste we already have generated before mining more.

Figure 2.3: This is an open pit mine. This mine is for iron.
Open pit mining is one of the ways to mine uranium from the earth.

Arielle Says . . .

One of the benefits of nuclear power is that it has the real potential of eliminating our dependence on fossil fuels for energy production. As in, *today*. We could replace the fossil fuel power plants we have with nuclear power plants.

I'm hopeful we can find a way to combine nuclear with low-carbon sources of energy, such as wind and solar.

4. Take out your remaining eight *Energy Source Cards*.
5. Divide the cards equally among your team members. Your team can decide whether each person wants to use the same cards as you did during the Discover activity or switch cards.
6. Think about any remaining questions you have about your energy source. What information from the Part 1 survey, Community Energy Observation, or Community Effects Investigation can you add to your cards?

a. For example, suppose you are responsible for the Solar Energy *Energy Source Card,* and in your community energy observations you noticed that people said they liked that solar energy was renewable, but the energy was only available when it was sunny out. This is helpful information to add to the card.

7. Read *At the Smithsonian*. How easy would it be to replace fossil fuels with sustainable energy in your community? What might be the challenges? Add those answers to your *Energy Source Cards*.

At the Smithsonian

Dr. Hal Wallace is curator of the electricity collections at the National Museum of American History in the Smithsonian Institution. Hal's job is to do research that helps educate people about the past and future of energy and electricity. Remember his quote as you find out more about energy sources.

"It's easy to say, 'Change to sustainable energy!' but you have to combine sustainable energy sources into the system that already exists. That can be difficult. For example, certain kinds of sustainable energy are not available all the time. Denmark found this out a few years ago. They get a lot of wind power from the winds on the North Sea. But they had a huge storm and their wind turbines had to shut down because the wind was actually too strong. The whole country lost power for several days."

8. Work on your own or as a team to research more information to add to your *Energy Source Cards*. Write "Benefits" and "Concerns" on each card.
9. Research about the benefits and concerns related to the energy source you were assigned. You can use books, articles, podcasts, websites, videos, interviews with experts, conversations with people in your community, or resources on the *Energy!* StoryMap.
10. Come back together with your team and read Arielle's quote. Discuss as a group, what are the benefits and concerns of using nuclear energy?

Arielle Says . . .

There are certain situations where solar and wind make sense. People should have those opportunities. I just want people to understand the limitations, too. So much energy is lost on power lines as the energy is **transmitted** to each community that needs it. In my opinion, when you need to power entire states, you need something that creates a lot of electricity, like nuclear energy, to help overcome the losses on the power lines.

Each solar panel generates an average of 2 **megawatts** of electricity. Which is great if you're powering something with relatively small energy requirements, like a home. But a nuclear power plant can generate 1,600 megawatts of electricity. Nuclear energy can deliver more power and use less land.

11. Share with the team what you have learned about your energy source. Have each team member explain the benefits and concerns about using the energy source they researched.

Act: *What energy sources meet the needs of my community?*

In this part, you and your team have examined what you already know about energy sources. You have also thought about what characteristics of energy sources are most important to you and your community. Now you will use this information to help you rank each energy source according to how it might help meet the needs of your community.

1. Gather as a team.
2. Get out your *Futures Mood Board*.
3. Quickly review the hopes and concerns on the board.
4. Read what Arielle says about why someone might want to use nuclear energy. How does that relate to the hopes and concerns of your community?

Arielle Says . . .

If young people are trying to choose an energy source for their community, a coal power plant is going to have a lot of environmental impacts right away that nuclear power just isn't. With nuclear, you aren't getting fumes and **carcinogens** into the air. You often see photos of nuclear cooling towers and people think the white substance coming out is pollution, but it isn't. That's steam and water vapor! It's not pollution!

With nuclear, there are always concerns of radiation getting into water or the living things in the community. But nuclear uses a sealed system so nothing is dumped into water sources. And because nuclear power plants produce so much energy, they can be placed farther away from where people live. Nuclear power plants are also highly **regulated** by the government and have inspectors at each power plant.

But especially given all the concerns around the safety of using nuclear, I think we need to be more **transparent** with people rather than less. It needs to be okay for someone to say, "I don't want this in my community!"

Figure 2.4: Steam rises from the cooling towers of a nuclear power plant.

5. Examine your other *Energy Source Cards*. Pay attention to your perspectives, benefits, and concerns. Are there any energy sources that you think might best help address the hopes and concerns of your community?
6. Arrange your *Energy Source Cards* in the order you think they would be most helpful for your community.
7. Record how you have arranged the cards using a photo, drawing, list, numbering the cards, or some other way. You will keep adding to your *Energy Source Cards* as you complete this guide. You might change your mind about which energy sources help meet the needs of your community, so it's important to be able to reflect back on what you thought in this part.

Congratulations!

You have finished Part 2.

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.

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

Atom: A very tiny particle that makes up all the things on Earth

Biofuel energy: A renewable resource that comes from living things (or things that were once living), such as wood, algae, corn, or animal dung or fat

Carcinogens: Substances that cause cancer

Chemical energy: Energy that is stored in the connections between atoms and molecules

Coal: A solid non-renewable resource that forms when living things die, are covered in layers of dirt and rock, and are compressed

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

Compressed: Flattened or pressed together

Concern: Something that causes anxiousness, worry, or fear

Consensus: A balanced decision that works for everyone in the group

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

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

Emit: To give off or give out something

Energy: Anything that gives the ability to do work

Engineer: A person who designs, builds, and maintains machines, structures, and technology that solves problems

Environmental: About the natural world

Equator: A line that goes around the middle of the globe dividing the northern and southern hemispheres

Ethical: The fairness of something

Fossil fuel: A type of fuel that comes from the fossilized remains of plants and animals

Geologic activity: The movement of Earth's tectonic plates that can cause earthquakes and the formation of volcanoes

Geothermal energy: Heat from the Earth that can be used to generate electricity

Greenhouse gases: Gases such as carbon dioxide and methane that cause the atmosphere to get warmer

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

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

Identity: The characteristics that make you you

Infrastructure: Built things that stay in your community(for example, bridges, buildings, train tracks)

Low-carbon: An energy source that releases very little carbon dioxide gas into the atmosphere

Megawatt: A way to measure electricity; 1 megawatt is 1 million watts

Mine: To remove something valuable from the ground

Natural gas: A non-renewable resource that forms when living things die, are covered in layers of dirt and rock, and are compressed

Non-renewable: Impossible or difficult to replenish

Non-renewable energy: Energy sources that run out faster than they can be naturally replaced

Nuclear energy: A low-carbon resource that works by breaking apart the center of atoms in uranium and using the energy from that reaction to generate electricity

Nuclear reactor: The part of the nuclear power plant that produces nuclear energy

Petroleum (oil): A liquid non-renewable resource that forms when living things die, are covered in layers of dirt and rock, and are compressed

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

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

Regulated: Controlled by law or an authority; required to follow certain rules

Renewable: Easily replenished

Renewable energy: Energy sources that are not likely to run out for a very long time or are replaced as fast or faster than they can be used

Sediment: Material that settles at the bottom of a body of water, or material that is deposited by wind, water, or glaciers

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

Solar energy: A renewable and low-carbon resource that converts light energy from the sun into electricity using solar panels or uses the heat of the sun to heat water or other substances

Social: Relating to the interaction of people in a community

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

Sustainable energy: Energy that can help people meet their needs now without harming or risking the future of the next generation

Transmitted: Moved from one place to another

Transparent: Easily accessed and understood

Turbine: A device spun by wind, water, steam, or gas that generates electricity

Uranium: An element of matter on Earth that is used in nuclear reactors

Wind energy: A renewable and low-carbon resource that converts wind, or the movement of air, into electricity using a wind turbine

Zero-carbon: Releases no carbon dioxide into the atmosphere

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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.

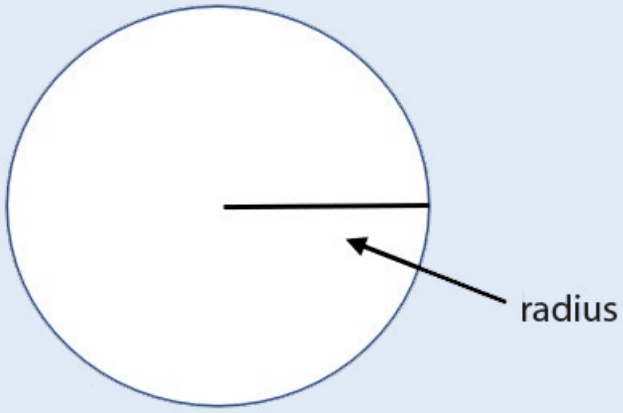

Figure 3.6: The radius of a circle; a slice through the center of a sphere is a circle.

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

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ENERGY!

Part 4:

Energy in the Community

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian
Science Education Center

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

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PART 4: ENERGY IN THE COMMUNITY

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 is energy used in the spaces in our community?					
Discover	Identify the spaces in the community that are important to you and explore how they use energy to help you meet your needs.	• Paper • Pens or pencils		10 minutes + extended observation time	102
Understand	As a team, select from three energy investigations that will help you learn about energy use in your community.	• Paper • Pens or pencils		10 minutes + community investigation time	105
Act	Use your *How I Meet My Needs* document and the results of your investigations to create a community energy use map.	• Paper • Pens or pencils • Art or craft materials (optional)	*How I Meet My Needs*	25 minutes	111

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: How can we use sustainable energy in our community?					
Discover	Examine data about energy use around the world and relate it to your local community.	• Paper • Pens or pencils	*Futures Mood Board*	15 minutes	115
Understand	Carry out investigations into how you can incorporate sustainable energy (such as micro-hydropower, micro-solar, and micro-wind power) into your community.	• Paper • Pens or pencils • Flexible hose • Funnel (or 2-liter bottle) • Measuring tape • Rocks, sticks, boards • 20-liter (5-gallon) bucket • Watch or timer	*Community Energy Use Map*	15 minutes + investigation time	117
Act	Use the *Community Energy Use Map* and your investigations from Understand to come up with sustainable energy solutions for your community, and brainstorm small actions you can take to reduce energy use.	• Paper • Pens or pencils	*Community Energy Use Map* *Futures Mood Board*	30 minutes	126

Meet Your Research Mentor

Meet Dr. Kiron Neale. Kiron (pronounced *KY-ron*) will be your research mentor to help you understand how **sustainable energy** can be used to meet energy needs in a **community** and how communities make decisions.

Kiron is a solutions engineer for a company that specializes in sustainable energy solutions. He has a master's degree in **environmental** change and management and a PhD in geography and the environment. He has special expertise on how small island nations can use **solar energy** to meet their energy needs and has done research in Trinidad and Tobago, Barbados, and O'ahu, Hawai'i. However, he also has knowledge and **perspectives** that come from other parts of his **identity**. Since Kiron is now working with you, it is important to understand who he is.

Kiron's Identity Map

- Male
- Indo and Afro-Caribbean
- Grew up in a rural village-town in Southern Trinidad
- Has brown eyes
- Has brown skin and black curly hair
- Likes hiking, painting, and beach walks
- Interested in energy efficiency
- Interested in solar energy and climate change
- Princes Town and San Fernando (Trinidad & Tobago) are important
- Madrid, Granada, Tenerife, and Murcia, Spain are important to him
- 33 years old
- Interested in behavioral and cultural change
- Interested in energy on small islands
- Average height
- Likes to listen to others
- Reserved, patient, dedicated, and optimistic
- Likes breakdancing, playing football, sprinting, and fitness
- St. Annes on the Sea, and Oxford (UK) are important to him

Task 1: How is energy used in the spaces in our community?

People use energy to meet needs such as lighting, heating or cooling air, keeping food cold, and heating water. A community can create a more sustainable energy future either by switching to **low-carbon** sources of energy or trying to find ways to use *less* energy to meet their needs by changing their habits or the items they use.

In this task, you will ***discover*** how the places in your community use energy to help people meet their needs. You will collect **data** to ***understand*** what energy in your community is used for, how much is used, and if there are areas of **inequity** in your community. Finally, you will ***act*** by creating a map of your community's energy use and deciding which spaces are most important to change.

Before you begin the rest of Part 4, think quietly to yourself about Kiron's identity map.

- Are there things you have in common with Kiron?
- Are there ways in which you are different from Kiron?
- Can you see anything about Kiron's identity that makes it easier for him to find sustainable energy solutions for buildings in a community?

During Part 4 you will notice Kiron sharing ideas and experiences with you. He may help you understand better ways to conduct investigations, or he may share some of the work he has done.

Discover: *What spaces do I use in my community?*

What are your favorite places in your community? Maybe it's a community center where you play games with friends, your home or a relative's home, a library, or a restaurant or food kiosk where you and your friends like to eat. There are places in every community that help people meet their needs. Those places use energy. In this activity, you will explore which places are most important to you, what kind of energy those places use, and what the energy is used for.

1. Get out a blank document. Title it "How I Meet My Needs"
2. Divide the document into four columns. Title the first column "Location," the second column "Why is this place important to me?," the third column "How does this place use energy?," and the fourth column "How could this place use energy to meet my needs better?" Figure 4.1 shows an example of this document.

How I Meet My Needs

Location	Why is this place important to me?	How does this place use energy?	How could this place use energy to meet my needs better?

Figure 4.1: Example of a blank How I Meet My Needs document.

a. Use the *Location* column to list any places in your community that help you meet your needs, such as a school, a restaurant, a health care center, or a gym or recreation center.

b. Use the *Why is this place important to me?* column to describe how you meet your needs at this place. What do you use it for? Why is it important to you?

c. Use the *How does this place use energy?* column to list the ways this place uses energy to meet people's needs. Read *How Energy Helps People Meet Their Needs* for more information.

How Energy Helps People Meet Their Needs

Energy is used in so many different ways in a community, but in this part, you can just focus on the following uses:

- Heating and cooling air indoors
- Heating water
- Keeping food cold with refrigerators or freezers
- Using lights or computers
- Washing or drying clothing and dishes

d. Use the *How could this place use energy to meet my needs better?* column to describe any need you wish could be met at this place but isn't being met right now. For example, you might wish that your school was better able to heat and cool the air so you could concentrate and be comfortable at school.

3. You can find out the information you need to fill in this document in several ways:
   a. You can use your memory to think about the places in your community that you use to meet your needs. You might remember places you use every day, or places you have only used once but were very important, such as a hospital.
   b. You can write down or record the places as you use them over a specific period of time, like a day or a week. Each time you use a place to meet your needs, you can record information about it.
   c. Move around your community and observe the places in your community. This can help you identify the places you use to meet your needs.
   d. Use a community map to help you identify the places you use to meet your needs.
   e. Ask a friend, a teacher, or a person in your home to help you think of the places you use to meet your needs. Or compare with a member of your class.
4. Record your answers in the *How I Meet My Needs* document. Figure 4.2 shows an example of how to do this. Try to record at least three places in your community on your document. You can also record more than three places, if you would like.
5. Find a safe place to keep this document. You will share it with your classmates later in this task.

How I Meet My Needs

Location	Why is this place important to me?	How does this place use energy?	How could this place use energy to meet my needs better?
My grandmother's house	I go once a week to eat at her house	Lights, a small refrigerator, and a hot water heater. My grandmother also has one tiny air conditioner in her window.	I wish my grandmother was better able to cool her home. I worry about her being too hot in the summer. But I know it's expensive to run the air conditioner.

Figure 4.2: Example of one entry in the How I Meet My Needs document.

⚠ Emotional Safety Tip

There might be some places that help you meet your needs that you would rather keep private. That's okay. You don't have to record or share any place in your community that you don't want to.

You may also feel uncomfortable when thinking about how places could better meet your needs. It might make you feel frustrated or like things are unfair. It's normal to experience those feelings. This guide can help you think of ways to make your community's energy use more fair.

Understand: *How does our community use energy to meet its needs?*

You and your team are using this guide to help your community make more sustainable energy choices in the future. One way to reach that goal is to investigate what sources of energy your community uses. If your community is using unsustainable sources of energy, you can try to help switch to more sustainable sources.

Another way to reach the goal of a sustainable energy future is to investigate *how* your community uses sources of energy. What does your community use energy for? How much energy does your community use? Can people change their behavior to reduce the amount of energy they use? Does everyone have the same **access** to energy? You will investigate some of these questions with your team.

1. Read Kiron's perspective about why it is important to use sustainable energy sources. Keep this perspective in mind as you plan your investigations.

Kiron Says . . .

Using sustainable energy sources can help reduce the **emissions** that cause climate change. But it's not only about emissions. You have some things that are basic needs, like food, clothing, and shelter. Energy is another one of those basic needs.

In thinking about a transition to sustainable energy, it's not just about switching to renewables. It's really thinking about, "What are the energy sources that we use? What does that mean for our community? How can we take steps at a local level to make sure we use energy responsibly, efficiently, and sustainably in the long term?"

2. Gather as a team.
3. Read about *Investigations 1, 2,* and *3*. These investigations can help you figure out how your community uses energy to meet people's needs. Decide which investigation each team member would like to do. Then carry out the investigation. You can work by yourself or with others. You can do one of the investigations, some of them, or all of them.

Investigation 1: Lighting Observation

a. Get out a piece of paper or choose another way to record information.
b. Pick one building or a group of buildings in your community that you can easily observe. You can pick buildings where people live, such as houses or apartment buildings. You can also pick buildings where people work, visit, or get goods and services, such as an office, a community center, or a food market.
c. Make the following observations about each building:
   - Time
     - What time does the building open and close to the people who use it?
     - Is the building open 24 hours a day?
   - Lights
     - Where does this building have lights? Inside, outside, in a sign, near a security camera, in a parking area?
     - Observe whether the lights in the building are still on after the building is closed and people are no longer using it. It may be easiest to do this by observing the part of the building that faces the street. Do not enter a building after it has closed. List any lights that stay on after the building has closed. For example, you might record, "The sign in the front is still lit up."

d. Work by yourself or with your team to identify why those lights may stay on. For example, a business may leave its lights on even when the building is closed to discourage anyone from breaking in. Or a parking area or bus stop may have lights on at night to help people see, move around safely, and feel safe when it is dark.

Figure 4.3: This office building has lights on at night even after most employees have left the building.

e. Work by yourself or with your team to identify any lights that you think could be turned off after the building is closed. Explain your reasoning.

⚠ Physical Safety Tip

Only make these observations if it is safe and comfortable to do so. Make sure you stay on public property. Feel free to ask a trusted adult for help or to go with you during this investigation. Some of the observations listed here might need to happen at night. If this is not safe in your community, you can choose another investigation.

Investigation 2: Energy in the Community Interview

a. Get out a piece of paper or choose another way to record information.
b. Pick one building or a group of buildings in your community that you can easily observe. You can pick buildings where people live, such as houses or apartment buildings. You can also pick buildings where people work, visit, or get goods and services, such as an office, a community center, or a food market.
c. Contact the people who own, manage, or use the building and ask if you can interview them about energy use in that building.
d. Work by yourself or with your team to write interview questions about what energy is used for, how much is used, and what could be better about energy use in the building.
e. Take your *Energy Source Cards* with you. If the person you are interviewing does not know about an energy source, you can use these cards to share information.

Suggested Interview Questions

Here are some interview question suggestions:

a. What kinds of energy does this building use? (There might be more than one kind of energy used. For example, perhaps the water is heated using natural gas, but the electricity comes from a coal **power plant**). If the person you are interviewing doesn't know, you could share your *Energy Source Cards* with them to help them think through the most likely options.
b. What does your building use energy for?
    - Do you use lights?
    - Do you heat or cool the air?
    - Do you heat the water?
    - Do you use refrigerators or freezers?
    - Do you have electronics such as dishwashers, clothes dryers, computers, or televisions?
c. What use of energy do you think you spend the most money on?

d. Do you ever feel like you aren't able to get or afford the energy you need to keep this building useful, comfortable, or safe for people?
e. Have you thought about asking people to change their behavior or habits to reduce the amount of energy this building uses? What ideas do you have?
f. Do you wish you could use a different source of energy for this building?

⚠ Emotional Safety Tip

People may be uncomfortable discussing money. Do not ask someone directly how much they spend on energy. If they choose to tell you that information, that's okay.

Investigation 3: Energy Equity Survey

Carry out a **survey** of the people who live in your community. Remember that Part 1, Task 1, Understand includes instructions on how to carry out a survey.

a. Decide whether you want to carry out the survey in person, over the phone, on the Internet, or another way. You can also use more than one way to get the most responses from your community.
b. Work by yourself or with your team to write survey questions. Choose questions that will help you figure whether people have access to energy, if that access is **reliable**, or if they are at greater **risk** than others. Some suggestions are listed here.

- Do you have access to energy where you live?
- Have you ever experienced a loss of power or a blackout where you live or work? How often does it happen?
- What do you use in your home to keep it comfortable? For example, do you heat the air or water in your home?
- Are you able to afford all the energy you need to keep your home safe and comfortable?

- Do you know of any parts of the community that experience greater heat or cold than other parts?
- Have you ever felt unsafe or unhealthy because you didn't have access to energy?

c. Choose five to ten questions for your survey.
d. Decide where, who, and how you will conduct your survey.
e. Conduct your survey by yourself or with your team and record the results.

⚠ Emotional Safety Tip

It can be upsetting for people to share that they cannot afford to pay for energy, to discuss blackouts, or to share information about their health and safety. If you are conducting this survey in person, be sensitive to the people you are surveying and allow them to skip any questions that make them uncomfortable.

4. Find a safe place to keep any data you recorded. You will share it with your teammates in the next activity.
5. Read Kiron's thoughts on how best to gather information from a community. Why do you think the investigation or investigations you just did are important?

Kiron Says . . .

Oftentimes, one does not necessarily connect with or relate to a culture unless you are in it or a part of it. For example, I'm Caribbean, and so, I can connect with the broader Caribbean culture and shared regional experiences. However, I'm not Barbadian, so I won't understand or connect with all the nuances of that specific culture fully. I'm also not Hawaiian or from the United States, so I won't fully connect with those cultures completely either. So, I approach it as, "You tell me and I'll listen." I am Trinidadian, so I do

know and connect with that culture quite well. But what I'm interested in at the end of the day is people's individual perspective. If someone is sharing their lived experience within a culture with me, I like to listen and empathize with their experience because it's not necessarily my cultural life or outlook.

Act: *What spaces in the community are the most important to make changes to?*

You have collected data about how the places in your community use energy to help you and other people meet their needs. You have investigated what sources of energy your community uses, what it uses energy for, how much energy it uses, and whether everyone in the community has access to energy. In this activity, you will continue to think about perspectives on energy use. You will also make a map of your community's energy use. All this information can help you figure out the best places and ways to take action on energy use in your community.

1. Read the following statement by yourself:
    a. "I own a business in my community. I keep the lights and air conditioning on 24 hours a day inside my business, even though it's only open from 10 a.m. to 4 p.m. I know this wastes energy, but I worry about people stealing from my store at night so I keep the lights on. And my community is so hot that if I turn the air conditioning off overnight, it's too hot to work inside the next day. My electricity comes from the nearby coal power plant. I want to switch to solar power, but it's too expensive to install."
2. Do you agree or disagree with how this business owner uses energy? Why or why not?
3. What perspectives do you notice in that statement? Remember that you learned about **social**, **economic**, environmental, and **ethical** perspectives in Part 2. The statement in step 1 includes multiple perspectives.
4. Find a partner and discuss the following:
    a. What perspectives did you notice?
    b. Which perspective do you think is the most important to consider?

c. What changes would you want this business owner to make? Why?

d. Is there any reason some of those changes might be difficult for the business owner?

5. Read Kiron's explanation of the kinds of perspectives that are most important to people when they make decisions about sustainable energy.

Kiron Says . . .

When people think about switching to sustainable energy, most people are concerned about economics. They might ask, "What is this transition going to look like for my wallet?"

But people also want more information to understand what this new technology actually does. For instance, the understanding of solar power in Barbados is very different from Trinidad. People in Barbados have used solar technology for much longer than people in Trinidad, so they understand the technology better.

It's important to give people the information they need about sustainable energy like solar. You want to move people from just being aware of sustainable energy to being comfortable enough to invest in it.

6. Take out your *How I Meet My Needs* document from the Discover activity.
7. Take out the data you recorded from the investigations in the Understand activity.
8. Read *Making a Community Energy Use Map* and follow the directions.

Making a Community Energy Use Map

You and your team are going to use the information you gathered in the Discover and Understand activities to make a map of your community. This map will help you represent the places in your community that are important to you, what you know about those places and how they use energy, and what you are concerned about. This map will help your team decide where to take action in your community. It can also help educate other members of the community about the work your team is doing.

a. Gather as a team.
b. Decide what kind of map you want to create. You can draw a map on paper, use a digital mapping tool, create a map using images, draw a concept map, or create a table that lists the places in your community. The map does not have to be perfect or show accurate distances. You are just using it to gather and display information.
c. Share your *How I Meet My Needs* document with your team.
d. Choose one or two places from your document that are important to each of you, and add those locations to the map. Figure 4.4 shows an example.

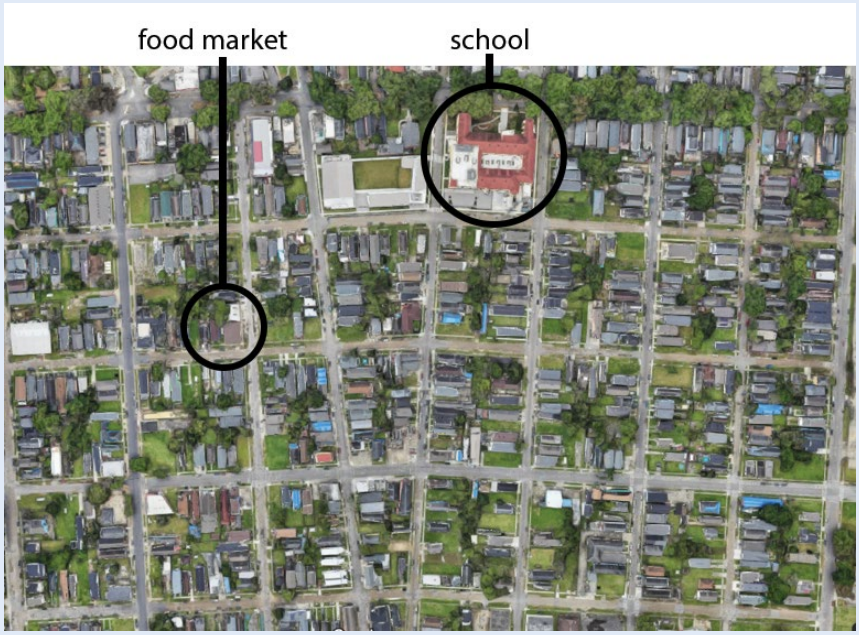

Figure 4.4: Example of a map with two places labeled that help you meet your needs.

e. Add information from your document to the map. If you can, try to record the information near the location on the map. For example, if you are using a paper map you could place a sticky note with information next to the location. Consider adding:
    a. Why this place is important to you
    b. What you are worried or concerned about
f. After each team member has added their information, notice if anyone else named the same places you did or had similar answers.
g. As a team, take out the data you recorded in the Understand investigations.

h. Choose a few places from your investigations that you are most worried or concerned about and add those locations to the map.

i. Add information from your investigations to your map. Some suggestions are listed here:

- Places that are important to you
- What energy sources are used, and what they are used for? Use your *Energy Source Cards* to help you remember the different sources of energy.
- Places where people sometimes feel uncomfortable, unsafe, or unhealthy because they do not have enough energy to meet their needs
- Areas where people have difficulty paying for energy

9. Consider your *Community Energy Use Map* as a team.
10. Discuss which places, buildings, or areas in your community **concern** you the most. You might be concerned about the source of energy, the way energy is used, how much energy is used, or an issue of energy **equity**.
11. Use a mark, circle, another symbol, or some other way to identify the places that concern you the most.
12. Keep this map in a safe place. You will use it in the next task.

Task 2: How can we use sustainable energy in our community?

In this task you will ***discover*** how you think and feel about global data and relate it back to your own community. Then you will ***understand*** more about the choices your community can make about sources of energy and behavior to help create a more sustainable energy future. Finally, you will ***act*** by thinking of behavior changes and adding solutions to your *Community Energy Use Map*.

Discover: *How do I think and feel about energy around the world?*

In Task 1 you and your team collected information about how your community uses energy to make spaces safe, comfortable, and usable. You investigated what sources of energy people use, how they use that energy, how much they use, and any issues related to energy equity.

Your local community is part of a larger, global community. The issues you have in your community may also be found in many other communities around the world. Thinking about connections between your community and the rest of the world will help you contribute to sustainable solutions that impact more than just your local area.

In this activity you will examine data about energy access and energy use around the world and think about how it relates to your community's sustainable energy future.

1. Examine the map in Figure 4.5 by yourself. This map contains data about how many people in the world had **access to electricity** in 2020. Each color on the scale represents a percentage of the population that has access to electricity in that country. This map defines "access to electricity" as having a source of electricity that can provide basic lighting, charge a phone, or power a radio for four hours a day.

Electricity Access, 2020

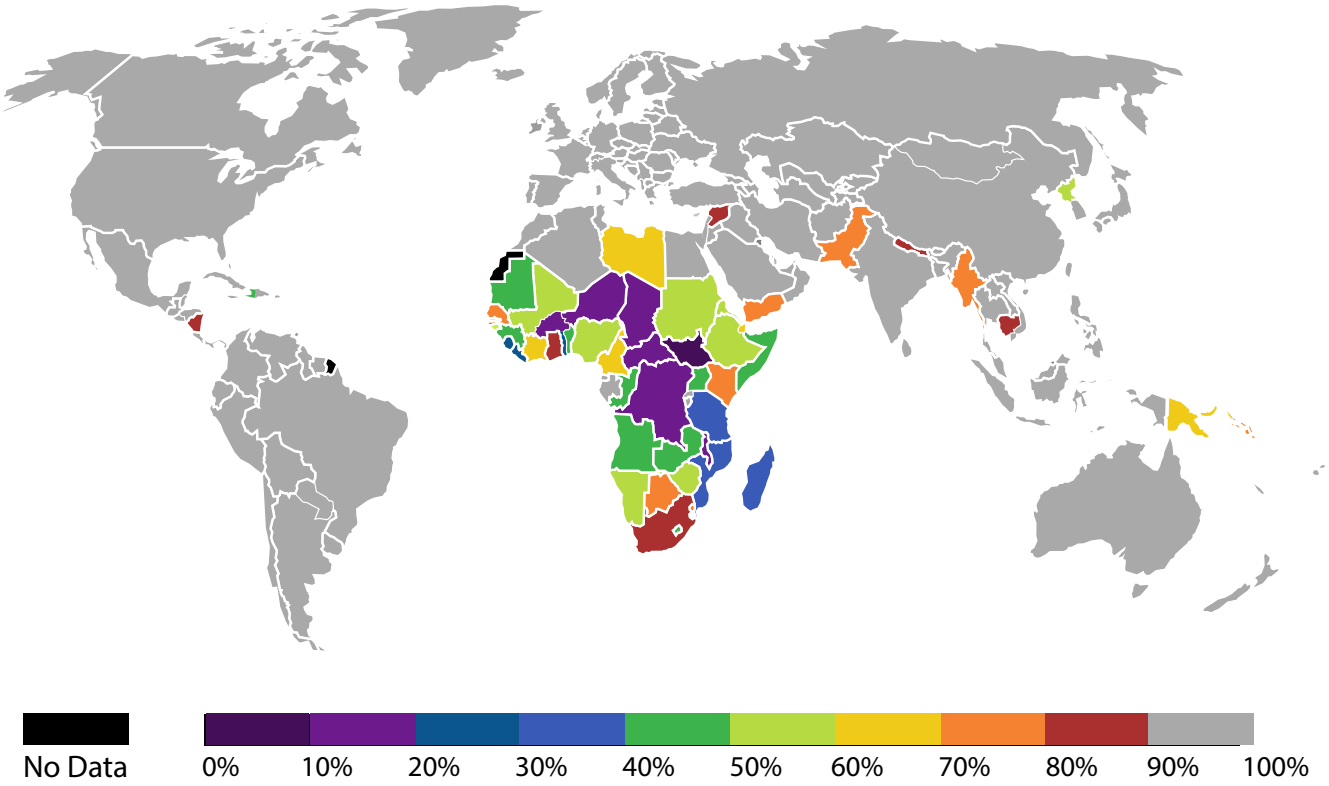

Figure 4.5: A map showing the percentage of people with access to electricity in each country.[1]

2. Think quietly to yourself about the following questions:
   a. What do you notice about this map?
   b. How does this map make you feel?
   c. Does this global map remind you of any parts of your local community? Are there areas where people lack access to electricity?
   d. What would you like to see change about this map in the future?
3. Gather as a team.
4. Share your answers from step 2. What answers surprise you?
5. Take out your *Futures Mood Board*. Think about the answers you just shared with your team. Is there anything you would like to add to your vision of a sustainable energy future, based on this data? Are there new **hopes** you want to add? Are there new concerns you want to add?

Understand: *How can we make changes to energy use in our community?*

You have collected data about energy use in your local community and the world. You've identified what you are most concerned about. Now it's time to start developing potential solutions. In this activity you and your team will have the option of conducting several investigations about the kinds of sustainable energy that are a good fit for your community.

1. Gather as a team.
2. Take out your *Community Energy Use Map*.
3. Take out your *Energy Source Cards*.
4. Find the marks you used to identify the places you are most concerned about. Review those places as a team. You may start to notice patterns in the concerns you have.
5. Review your *Energy Source Cards*. Discuss the following questions:
   a. What do we want to change about the sources of energy our community uses?
   b. What do we want to change about the way our community uses energy?
6. Read *At the Smithsonian* to find out more about how generating renewable energy locally might be helpful.

At the Smithsonian

Dr. Hal Wallace is the curator of the electricity collections at the National Museum of American History in the Smithsonian Institution. Hal's job is to do research that helps educate people about the past and future of energy and electricity. Right now, many people get their power from an **electric grid**. An electric grid is a network that connects producers of energy, such as power plants, with consumers of energy, such as homes and businesses.

However, this isn't the only option. Hal says, "You don't have to have huge electrical grids. You can have micro-grids. If you have renewable energy produced at the local level, it can help you avoid a blackout in your community. The large electrical grid might fail because of a storm or a tree falling, but anyone connected to the micro-grid can stay up and operational."

7. Read *Renewable Energy Investigations 1*, *2*, and *3* to learn about ways you could generate electricity in your community. Some types of renewable energy are best for certain types of places. Which type would you guess might work best in your community?
8. Decide which investigation would be right for you and carry out that investigation. You can work by yourself or with others. You can do one of the investigations, some of them, or all of them. Try to investigate types of renewable energy that you think might work well in your community.

Renewable Energy Investigation 1: Micro-Hydropower

Hydropower involves using the force of flowing water to turn a **turbine**. The turbine connects to a generator, which can generate electrical energy. You may know about hydropower because you have noticed hydroelectric dams or tidal hydroelectric systems on the coast. Those systems can supply energy to an entire community.

A **micro-hydropower** system can supply energy to a much smaller area, such as a single house. In this investigation you will build a simple version of a water turbine called a water wheel that can help you investigate whether the flowing water in your community is a good match for micro-hydropower.

Gather information on water wheels

Have you ever noticed water, wind, or sand turning something? You may have noticed something big like a water wheel, or something small like a toy. Think carefully: What are the different parts that allow something to spin as water, wind, or sand flows over it?

Examine Figure 4.6. What parts do you notice in this water wheel?

Figure 4.6: A water wheel.

You will now design your own water wheel. Before you start, try to gather information about how others have designed a wheel that turns as water flows past it. You could:

a. Go online or to a local library and search for images or diagrams of water wheels.
b. Search for videos of water turbines and water wheels in use. The *Energy!* StoryMap has some examples.
c. Think about examples of water turbines you have noticed in your area. Ask others in your community about whether they have ever noticed water wheels or water turbines.

Turn to a partner and talk about the important parts of water wheels. Not all water wheels will look the same, but you and your partner should discuss what water wheels usually have in common. For example:

a. What shape are most water wheels?
b. What makes a water wheel turn?
c. What provides structure to a water wheel?

Think about how water wheels might generate electricity, and discuss your ideas with your partner.

a. Would it be better for the wheel to spin quickly or slowly?
b. How does the amount or speed of the water affect how a water wheel spins?

Plan and create a water wheel with your partner

Gather your materials to build your water wheel. You can use any materials that you can find easily, but you might want to consider these types of items:

a. Something circular, such as a paper plate
b. Things to temporarily catch water, such as paper or plastic cups or parts of plastic water bottles
c. Something to attach items together, such as glue, tape, string, or rubber bands
d. Something to twirl at the center of your wheel, such as a wooden stick or a straw
e. Pencils, pens, color pencils, or markers

Work with a partner, a small group, or your whole team to design your water wheel.

a. Plan your water wheel. You may want to draw it and include which materials you plan to use.
b. Create your water wheel according to your plan. If you need to, you can make changes to your plan along the way. You are **engineering** and often that means you need to adjust your plan if something is not yet working.

Test your water wheel and make observations

Find an area nearby that has running water, like a bathroom, kitchen, or classroom sink. If you do not have access to running water indoors you can also use natural areas such as a stream, creek, or small river.

a. Take out something to help you record your observations.
b. Place your water wheel in the running water to find out if it will spin. You can hold your water wheel as it spins, but you cannot help the wheel spin.
c. Take notes on how your water wheel moves. Does your water wheel spin when water flows through it or is poured on it? If not, what might be preventing your water wheel from spinning?
d. Discuss with your group:
    - What worked well and what did not work well in your first trial?
    - Are there changes that you want to make to your water wheel? For example, maybe you want to replace, strengthen, or add a part.
e. Make any changes you want and test again.
f. Continue until you are happy with your water wheel.

Find places in your community that might create micro-hydropower

a. Use a map of your local community and identify all the places in your community where water flows naturally. These are places like streams, creeks, or small rivers. Maps can be found online, at your school, or at your local library. If you cannot find a map, just think about places where you know water flows in your community.
b. With your team, discuss:
    - Which spaces in your community have naturally flowing water?
    - Does everyone in your community have access to natural sources of flowing water?

c. If you can, bring your water wheel to one or more of the locations you identified on your map and test it. If the water wheel spins, it may mean this location could be a good place for micro-hydropower.
d. If you can, find a way to compare how fast your water wheel spins at different locations. Which place might generate the most electricity?
e. If you cannot go to a water source, think about your past experiences. Is there a place in your local area where water flows quickly all the time? If you could choose, where would you put a water wheel to generate electricity?

⚠ Physical Safety Tip

Always ask permission from an adult to do investigations in water. Do not go into fast-flowing water that is deeper than your ankles or mid-calf. Always have another person present when working near or in water. Make sure you have a change of clothes available in case you get wet. Wash your hands thoroughly after touching the water.

If you are interested in finding out how much electricity flowing water can generate, the *Energy!* StoryMap has details about an investigation you can do.

Renewable Energy Investigation 2: Micro-Solar

Solar power captures energy from sunlight to generate electricity or to heat water.

You may have noticed large solar farms with many solar panels. But individuals, small groups of people, and communities can also use smaller, local micro-solar power that use fewer solar panels. This investigation will help you investigate whether there are any sites in your community, such as your school or home, that are a good match for micro-solar power.

Figure 4.7: Several buildings are using this micro-solar grid on Selakan Island in Malaysia.

a. Use paper or another way to record your observations and information.
b. Observe the site you want to investigate to make sure it gets at least four hours of direct sunlight per day. Direct sunlight means light from the sun lands directly on a site without being blocked by an object or material.
c. Check the site to see if there are nearby objects that might create shade, such as tall buildings, tall trees, or hills and mountains.
d. If you live in the northern hemisphere, figure out if you can place your solar panel on a high surface facing south, such as a roof. If you live in the southern hemisphere, figure out if you can place your solar panel facing north.
e. Move around your neighborhood to see if any nearby homes or buildings use solar power. If you are able, contact the owners of those homes or buildings and ask them about the sun conditions in the area and how much hot water or power they are able to generate.

Renewable Energy Investigation 3: Micro-Wind

Wind energy captures energy from moving air, or wind, to turn a turbine, which connects to a generator.

You may have noticed wind farms with many wind turbines. But individuals or small communities can also use fewer or smaller turbines to create micro-wind power. This investigation will help you investigate whether there are any sites in your community, such as your school or home, that are a good match for micro-wind power.

a. Use paper or another way to record your observations and information.
b. A good site for wind power usually has an average wind speed of at least 14 kilometers (9 miles) per hour. Measure the average wind speed at a site in one of the following ways:

- Use the average wind speed data from a nearby airport. Keep in mind that wind speed can vary based on the height at which it is measured and surrounding objects. But the airport data is a good start.
- Check to see if your community, state, or country has wind maps. These maps display the average wind speed.
- Observe tall trees near the site for signs of **flagging.** Flagging is when a tree changes shape because of long periods of wind. Figure 4.8 shows an example. Higher average wind speeds cause more flagging in local trees. If you notice flagging in the trees near your site, it might be a good site for wind power. You can also use the Griggs-Putnam Index of Deformity in Figure 4.9 to help you.

Figure 4.8: A tree that is flagging because of strong winds in the area.

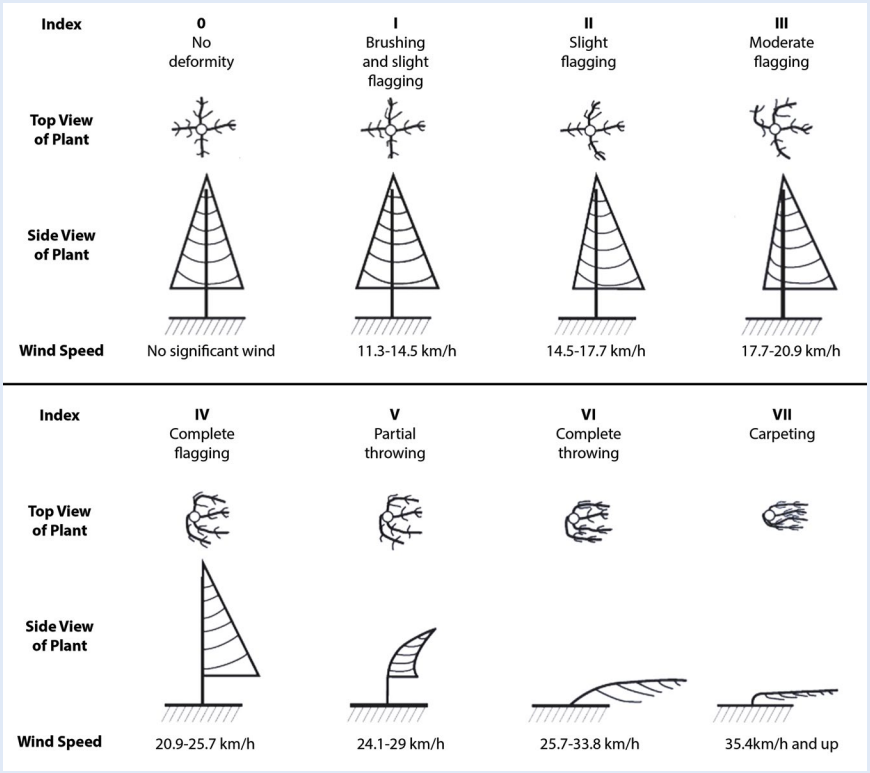

Figure 4.9: The Griggs-Putnam Index of Deformity.[2]

c. Observe the site for any tall objects that might get in the way of wind flow. These objects might be tall buildings, hills, tall trees, or young trees that will grow larger over time. If your site is surrounded by a large area of flat, smooth land, it might be a good fit for wind power.
d. Move around your neighborhood to see if any nearby homes or buildings use wind power. If you are able, contact the owners of those homes or buildings and ask them about the wind conditions in the area and how much power they are able to generate.

9. After your investigations, discuss with your team:
   a. Remembering the results of your investigations, which type of micro-renewable energy do you think might be the best for your community?
   b. Are there other things you need to consider besides the environment around you?
10. Read Kiron's thoughts about other things you might need to consider if you are thinking about solar power. What might be some similar considerations for hydro or wind power?

Kiron Says . . .

If students are wondering, "Would solar be a good option for a home?" they may want to think about, "Is it sunny enough?" and not just on that one day, but across the entire year. They should also think about if the home is strong enough to support solar panels on the roof. Solar panels last for up to 25 years or more, so the house should be strong enough to hold them for a long time.

They should think about if the resident owns the home or rents. If you are renting, you probably can't put the panels on the roof. Even if you are allowed to put panels on the roof, you have to work with your landlord or landlady to decide who actually owns the panels and the energy they produce. You also have to think about the number of people in the home and how much energy you will need.

An example of a cultural consideration is, "Will people be able to see the panels when they walk by?" This is an issue that comes up a lot in the United Kingdom, where you have **listed buildings** with strict rules. These rules guide any changes that can be made to the building. In general, it is more complicated to put solar panels on these buildings because they are protected by law.

11. Keep your observations and information about renewable energy in a safe place. You will use them in the Act activity.

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

In this part, you and your team investigated energy use in the places in your community that are important to you. You have explored energy use and energy equity locally and globally. In Task 2, you began to investigate solutions for a more sustainable energy future.

In this activity, you will use your *Community Energy Use Map* and the information you gathered in this part to help you add to your *Futures Mood Board* and come up with sustainable energy solutions for your community.

1. Gather as a team.
2. Get out your *Community Energy Use Map*. Review the concerns you discussed in Task 2, Understand, step 5.
3. Add any information from your Task 2, Understand investigations that will help you create sustainable energy solutions to address those concerns. Record those solutions directly on the *Community Energy Use Map*.
    a. For example, if there is an area of your community that does not have access to electricity, it might be a good idea to add some micro-sources of energy to that area.
4. Work with your team to think of how changes in behavior could help provide sustainable solutions. Remember that changing to low-carbon sources of energy is just one way to create a more sustainable energy future. When your team examines the *Community Energy Use Map*, how could changes in behavior create solutions to your concerns? Here are some suggestions:
    a. Set the thermostat several degrees higher in high temperatures or lower in low temperatures. This means you use less energy for cooling and heating. You could use fans or warm clothing to stay comfortable.
    b. Use motion-sensing lights that turn off when no one is using a space.
    c. Make different choices about items in your home that use energy. For example, you could switch to LED light bulbs, which use much less energy than incandescent or halogen bulbs.
    d. Take shorter showers or smaller baths.
    e. Wash clothes with cold water.
    f. Use a smaller refrigerator.
5. Read Kiron's thoughts on how to make sustainable energy a part of a community's culture and behavior. How could you use his suggestions in your sustainable energy solutions? Add any ideas to your *Community Energy Use Map*.

Kiron Says . . .

I think about sustainable energy technology as part of community's culture. Imagine that you have a large solar farm in one part of a community, but you don't see it or interact with it on a daily basis. You may not really know where you are getting your power from. Now imagine you have solar panels on your rooftop. You actually interact with the thing that is helping you generate electricity. The solar panel technology becomes part of your culture.

In Barbados, people use solar energy to heat water. The people in Barbados realize that solar is one of their sources of energy because they can see it on top of their roofs. They can actually describe how the system works. Because they've had that contact time with solar power, they understand it. Solar power has become a part of their energy culture.

6. Stop and examine the suggestions your team came up with in step 4. What are some social, ethical, environmental, or economic perspectives you should consider when suggesting that people change their behavior? For example:
   a. A hospital may not be able to safely change its indoor temperature without causing health or comfort problems for patients.
   b. A restaurant may not be able to serve all its customers if it switches to a smaller refrigerator.
7. Add any information from steps 4 and 6 that will help you create sustainable energy solutions to the concerns on your *Community Energy Use Map*. Record those solutions directly on the map.
8. Keep your *Community Energy Use Map* in a safe place. You can use it to help develop your action plan in Part 7.
9. Get out your *Futures Mood Board* and add any helpful information from this task. You may want to add some of your solutions in the *Hopes* section.

Congratulations!

You have finished Part 4.

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.

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

Access to electricity: Having a source of electricity that can provide basic lighting, charge a phone, or power a radio for four hours a day

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

Concern: Something that causes anxiousness, worry, or fear

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

Economic: About money, income, and the use of wealth

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

Emission: Material that is sent into the air, such as exhaust from a car

Energy: Anything that gives the ability to do work

Engineering: Designing, building, and maintaining machines, structures, and technology that solve problems

Environmental: About the natural world

Ethical: Something that is fair

Equity: Fair treatment of all people

Flagging: A process by which tree branches bend or break in the direction of the prevailing (or most common or constant) wind

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

Identity: The characteristics that make you you

Inequity: Unfairness

Listed building: A building with special historical or architectural significance that is protected by law

Low-carbon: An energy source that releases very little carbon dioxide gas into the atmosphere

Micro-hydropower: A small hydroelectric plant that can generate up to 100 kilowatts of electricity

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

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

Reliable: Dependable or gives the expected result over and over

Risk: The possibility to lose something, be harmed, or injured

Social: Relating to the interaction of people in a community

Solar power: A renewable and low-carbon resource that converts light energy from the sun into electricity using solar panels or uses the heat of the sun to heat water or other substances

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

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

Turbine: A device spun by wind, water, steam, or gas that generates electricity

Wind energy: A renewable and low-carbon resource that converts wind, or the movement of air, into electricity using a wind turbine

End Notes

1. Ritchie, Hannah, and Max Roser. 2022. Energy Access. *OurWorldInData.org.* Retrieved from https://ourworldindata.org/energy-access
2. Office of Energy Efficiency and Renewable Energy. Small Wind Guidebook. *Energy.gov.* Accessed September 8, 2023. Retrieved from https://windexchange.energy.gov/small-wind-guidebook

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ENERGY!

Part 5:

Using Energy to Get Around

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian
Science Education Center

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

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Science Curriculum Developer - Logan Schmidt

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PART 5: USING ENERGY TO GET AROUND

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 is energy used for transportation in our community?					
Discover	Ask yourself and others in your household about your transportation use.	• Paper • Pens or pencils		10 minutes for reflection + interview time	141
Understand	As a team, select from three investigations that will help you learn about transportation in your community.	• Paper • Pens or pencils • Internet (optional) • Paper or online map (optional)	*Energy Source Cards*	10 minutes + community investigation time	142
Act	Use your *How We Use Transportation* document and the results of your investigations to create a list of what you want to keep the same and what you want to change about transportation in your community.	• Paper • Pens or pencils	*How We Use Transportation*	40 minutes	151

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: How can we make transportation more sustainable?					
Discover	Explore the Avoid, Shift, and Improve strategy and think about how it could be used in your own community.	• Paper • Pens or pencils	*Futures Mood Board*	25 minutes	154
Understand	As a team, select from three investigations that will help you learn about transportation in your community.	• Paper • Pens or pencils • Paper or online map (optional)		5 minutes + investigation time	156
Act	Use the information from Task 1, Act, and Task 2, Discover and Understand, to redesign the transportation in your community.	• Paper • Pens or pencils • Video or audio recording equipment (optional) • Camera (optional)	*Futures Mood Board*	60 minutes	159

Meet Your Research Mentor

Meet Felipe Ramírez Buitrago. Felipe (pronounced *Fel-EE-pay*) will be your research mentor to help you understand how **sustainable energy** can be used for transportation and how communities make decisions.

Felipe is the director of urban mobility at the World Resources Institute's Ross Center for Sustainable Cities. Felipe has a bachelor's degree in civil and industrial engineering. He also has a master's degree in urban planning and a master's degree in construction engineering and management. He has special expertise on how to use sustainable energy to create **equitable** and **inclusive** transportation in cities. Felipe used his knowledge to help the city of Bogotá in Colombia switch to electric buses for public transportation. Bogotá now has the second-largest **fleet** of electric buses in the world.

However, he also has knowledge and **perspectives** that come from other parts of his **identity**. Since Felipe is now working with you, it is important to understand who he is.

Felipe's Identity Map

- Male
- 38 years old
- Latin American
- Has a beard, black eyes, and is tall
- Lives in Washington, D.C.
- Bogotá, Colombia, is special to him
- Likes to walk, read, and travel
- Listens to all types of music
- For fun he uses a bike
- Eats all kinds of food
- Interested in quality of life
- Is not shy
- Values positivity over **pessimism**
- Likes to help others, including animals
- Interested in **urban planning** and transport planning
- Has a tattoo of a bike on his ankle
- Wants to achieve sustainable, equitable, and inclusive cities for all
- Was the CEO of TransMilenio, a bus-based **rapid transit** system

Task 1: How is energy used for transportation in our community?

Transportation is about moving people and things from place to place. Sometimes people or things are moved using energy from people, such as walking, using a bicycle, or pushing a wheelchair. Sometimes we use other sources of energy, such as gasoline or petrol, electricity, biofuel, solar power, or wind. Cars, buses, trains, airplanes, and ships are all examples of transportation that use these types of energy sources.

Right now, most kinds of transportation around the world use non-sustainable sources of energy. But communities can make choices about the sources of energy they use for transportation. These choices can help make transportation more sustainable, safer, cheaper, and more **accessible**.

In this task you will ***discover*** how you and people in your household use transportation and what **concerns** or worries you. You will collect **data** to ***understand*** more about the sources of energy used for transportation in your **community**, how transportation is used by people in your community, and **equity** and transportation. Finally you will ***act*** to create a list of the most important perspectives to remember when thinking about a sustainable future for energy in your community.

Before you begin the rest of Part 5, think quietly to yourself about Felipe's identity map.

- Are there things you have in common with Felipe?
- Are there ways in which you are different from Felipe?
- Can you see anything about Felipe's identity that makes it easier for him to find sustainable energy solutions for transportation?

During Part 5 you will notice Felipe sharing ideas and experiences with you. He may help you understand better ways to conduct investigations, or he may share some of the work he has done.

Discover: *How do people in my community move from place to place?*

There are many ways to move from place to place. Some people walk, use a wheelchair, ride a bike, use a private car, or take the subway. In this activity, you will explore how you and the people in your household use energy through transportation to meet your needs. This information will help you figure out what you want to change about energy use and transportation in your community.

1. Get a blank document. Title it, "How We Use Transportation." You will use this document to record all the ways you and the people in your household use transportation in a day, a week, or another period of time that your team chooses.
2. Divide the paper into three rows. Label the rows "Types of Transportation," "Effect on Me," and "Energy Sources."
3. Answer these questions and record your answers in your document:
    a. Under *Types of Transportation* answer: What kind of transportation do I use to get from place to place? Why?
        - For example, "I went to school today using a public bus. I went home on a public bus. We don't have a school bus so I use the public bus. My friend's parent used their car in the evening to take me and my friend to sports practice. I walked home from the sports field because it would save my family money and because the bus stop is not close to the field."
    b. Under *Effect on Me* answer: How do my transportation choices affect me? Consider the four perspectives: **social**, **environmental**, **economic**, and **ethical**.
        - For example, "I sit and talk to my friend when we are riding the bus to school together. It is a good part of my day (social perspective). When I am walking home from my sports practice there is a lot of exhaust from cars around me (environmental perspective). It costs a lot of money to own a car, so my family does not have one (economic perspective). It sometimes feels unfair that moving around takes much less time for people who have cars (ethical perspective)."

c. Under *Energy Sources* answer: What kind of energy sources does your transportation use? If you don't know, you can ask whoever is driving the vehicle or use your *Energy Source Cards* to help.
   - For example, "The bus runs on gasoline. My friend's parents' car is electric."

4. Interview one or two people in your household using the same questions. Record their answers on your *How We Use Transportation* document.

> **⚠ Emotional Safety Tip**
>
> Difficulties with transportation can create problems with a person's health, education, and relationships with others. This may be true for you or people in your household. This might make you feel angry, sad, or upset. These feelings are normal. It is important to think about difficult situations in your community because that means you can consider ways to help make them better. However, it is okay to ask to pause if you are uncomfortable or upset.

5. Keep your *How We Use Transportation* document. You will need it in the rest of this part.

Understand: *How does transportation affect my community?*

You and your team are trying to help your community use sustainable energy for transportation. First, you need to know more information about how your community gets from place to place, what energy sources are used, and how people are affected by transportation.

In this activity, you and your team will plan and carry out investigations about transportation in your community. The data from these investigations will help you decide what is most important to change about transportation in your community.

1. Read *How People and Things Move from Place to Place* on your own.

How People and Things Move from Place to Place

There are many kinds of transportation around the world. Some kinds of transportation, such as rolling, walking, and riding a bicycle, use energy from people to move. Other kinds of transportation use manufactured sources of energy such as the ones listed on your *Energy Source Cards*. The kinds of transportation are listed here.

Light-duty vehicles typically move small numbers of people or amounts of things. Examples are cars, motorcycles, electric bicycles, electric scooters, auto-rickshaws, motorized tricycles, minivans, and smaller pickup trucks.

Heavy-duty vehicles typically move large numbers of people or amounts of things. Examples are large vans, large pickup trucks, tractor-trailers, garbage trucks, cement trucks, or buses.

Figure 5.1: This bus is able to move many people at once, but it uses a non-sustainable form of energy.

Rail is a form of transportation that can move people or things along a railroad track. Examples are trains or subways.

Ships move people or things on bodies of water. Examples are cargo ships, container ships, ferries, cruise ships, or barges.

Aircraft move people or things through the air. Examples are airplanes or helicopters.

Off-road vehicles move people or things in areas without roads. Examples are tractors, bulldozers, all-terrain-vehicles, mining equipment, or ride-on lawn mowers.

Pipelines move liquids over a distance using a large pipe and pumps.

2. Gather as a team.
3. Read *Investigations 1*, *2*, and *3*. These investigations can help you figure out more about transportation and energy use in your community. Decide which investigation each team member would like to do. You can work by yourself or with others. You can do one of the investigations, some of them, or all of them.

Investigation 1: Energy for Transportation in Our Community

Most forms of transportation still use non-sustainable sources of energy. This means changing to sustainable sources of energy for transportation could help lower your community's **greenhouse gas emissions**.

This investigation will help you figure out the kinds of transportation in your community, the sources of energy they use, the ways they help people, and the things that worry or concern you. You can use this investigation to help you make decisions about switching to more sustainable sources of energy.

a. Get out a piece of paper or choose another way to record information.
b. Make a table like the one in Figure 5.2. The first line has been filled in as an example, but you should fill in the answers from your own perspective.
c. Work with your team to gather the information to fill in the table. You can:

- Observe the transportation in your community directly. For example, you could observe one road in your community over a period of time, or move around the parts of your community and record any kind of transportation you notice, such as buses, tractors, cars, ferries, or pipelines.

> ⚠ **Physical Safety Tip**
>
> If you are near a road, be careful of vehicles like cars and bicycles. Make sure you pick a spot to make your observations where you can be safe.

- Communicate with others in your community about the kinds of transportation they have observed, the sources of energy used, and what benefits or worries them. Ask them why they use a certain kind of

transportation. Is it because it saves time, money, or makes them feel like they belong? Do they use a certain kind of transportation because of what it makes people think of them? You could do a **survey** or an interview.

- Use the Internet to research the sources of energy for each kind of transportation you observe, or use your *Energy Source Cards*. Or you could communicate with community members such as bus drivers, truck drivers, railway companies or railway engineers, public subway operators, taxi drivers, ferry operators, farmers, construction workers, people who have a personal vehicle, or pipeline operators or engineers.
- Examine a paper or online map of the public transportation in your community to explore what kinds of buses, trains, ferries, trolleys, or subways are available.
- Ask your local government for a list of kinds of transportation in your community. For example, a department of motor vehicles may be able to tell you the kinds of transportation that are registered in your community.
- Remember that you made observations about energy in the Community Observation Activity in Part 1, Task 2, Discover. You can also use those observations to help you fill in the table.

Kind of transportation	What have we observed in our community?	What source of energy does this transportation use?	How does this transportation help my community?	What worries or concerns me?
Light-duty vehicles	Car, motorcycle	Gasoline from petroleum, some electric vehicles	Helps people get exactly where they want to go	Loud, makes air pollution, causes traffic
Heavy-duty vehicles				
Rail				
Ships				
Aircraft				
Off-road vehicles				
Pipelines				

Figure 5.2: A table for recording the kinds of transportation in a community, with the first row filled in as an example.

Investigation 2: Energy to Transport People in Our Community

Light-duty vehicles are some of the biggest contributors to greenhouse gases because they mostly use non-sustainable fuels like gasoline and diesel. And many light-duty vehicles are only used by one or two people at a time, even if they have enough seats for several people. This means that not only do light-duty vehicles contribute to **climate change**, but they are not moving as many people as they could.

In this investigation, you will observe both the light-duty and heavy-duty vehicles using a road in your community and record how many people are being moved by each vehicle.

a. Work by yourself, with a partner, or as a team.
b. Find a safe, comfortable, accessible place where team members can stay in one place and observe vehicles that are using one section of road. Choose a place and time that allows you to observe plenty of vehicle traffic. Make sure you are not too close to the road or distracting drivers as you do your investigation. You could also do this investigation by recording vehicle traffic with a video camera that you leave in one place. You could also use an online traffic camera recording of a local road or highway, if one is available in your community.
c. Decide how long you would like to observe. It can be just a few minutes or longer.
d. Get out a piece of paper or choose another way to record information.
e. Make a table like the one in Figure 5.3.
f. As light- and heavy-duty vehicles pass by, observe how many people are in each vehicle. If you observe one person in the vehicle, make a mark in the *Vehicle with one person* column. If you observe more than one person in the vehicle, make a mark in the *Vehicle with more than one person* column.

    - This observation uses sight. If you have team members who are blind or low-vision, talk to them about any tools they typically use to take part in investigations that involve sight. Make sure those tools are available. Or

discuss how these team members could help with recording or analyzing data instead of collecting it. Consider describing the vehicles as they pass so all team members feel included in the process.

Vehicle with one person	Vehicle with more than one person
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X	X X X X X X

Figure 5.3: Sample table with the results of an observation of light- and heavy-duty vehicles.

Investigation 3: Transportation, Energy, and Barriers

Often people want to make sustainable transportation choices that use less energy. But not everyone has the same **access** to transportation and transportation choices. Figure 5.4 has more information about global access to public transportation, which is often a more sustainable form of transportation.

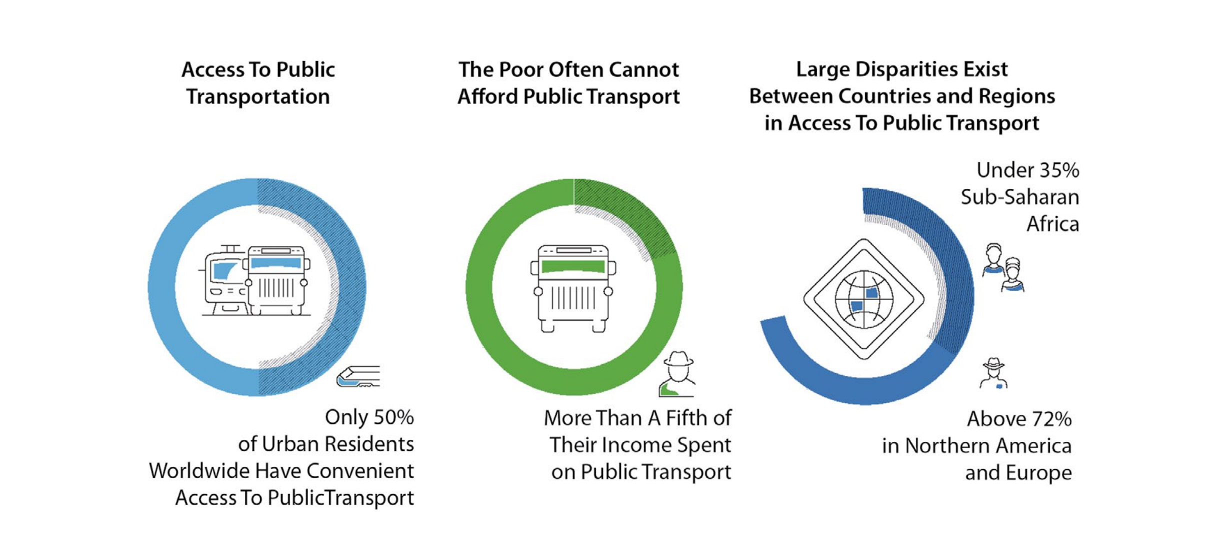

Figure 5.4: This graph from the United Nations shows access to public transportation in urban areas.

In this investigation, you will find out more about transportation and equity in your community. You will investigate barriers that make it harder for people to choose sustainable kinds of transportation.

This will help you figure out which parts of your community are most important to change. Then, you and your team can design solutions that use sustainable energy to make these changes happen.

a. Work by yourself, with a partner, or as a team.
b. Pick one or more sustainable transportation choice(s) you would like your community to make.
    - Sustainable public transportation: Use more public transportation, such as public buses, subways, or trains
    - Sustainable individual transportation: Use more sustainable individual transportation, such as a bicycle or an electric car
c. Think about the barriers or reasons people are unable to do something. Use your social, environmental, economic, and ethical perspectives to help you think. For example:
    - Sustainable public transportation: Are there cultural reasons people do not use public transportation? Is it possible for someone with a disability to access public transportation? Is it expensive to use? Do some people feel uncomfortable or unsafe using it?
    - Sustainable individual transportation: Are there health reasons people do not feel comfortable walking or bicycling? Is the air pollution a problem? Is it too expensive to buy an electric car? Are only some people in your community able to safely use a bicycle due to where they live?
d. Decide which barrier you would like to investigate further.

Gather Information

You can gather information about your community in many different ways. For example:

Mapping access: Use a map of your community that shows the location of areas or neighborhoods, buildings, roads, and public transportation. You may need more than one kind of map to gather all this information. You can use paper maps, maps you make yourself, or online maps. You can also directly observe your community.

- If you are researching sustainable public transportation, you could circle places such as bus stops or train stations that offer access to public transportation. Then notice whether there are some communities that are far away from places where they could get on public transportation.

- If you are researching sustainable individual transportation, you could search for things like bike lanes that make it easier and safer to ride a bicycle, or sidewalks that make it easier and safer to walk. Are there more bike lanes or sidewalks in some parts of your community?

If you need more ideas, you can also use the *Sustainable Communities!* community research guide. Part 5, Task 2, Discover, has information about making maps of transportation in a community.

Affordability: What are the economic reasons people feel they cannot make choices to save energy in transportation? You can find out this information in different ways:

a. Examine prices: Use online resources or printed materials to collect the prices of transportation. For example:
   - If you are researching sustainable public transportation, maybe you want to examine ticket prices and how that relates to different people's daily income.
   - If you are researching sustainable individual transportation and you would like to encourage people to switch to electric cars, maybe you can research the price of electric cars or the cost of electricity to charge a car versus a tank of gasoline. Can most people in your community afford to switch?

b. Interview: You could talk to people who are using public transportation or making decisions about individual transportation and ask them about their economic concerns.

⚠ Emotional Safety Tip

It can be hard to communicate with 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.

Figure 5.5: This photograph shows several ways that people move from place to place. Do you notice anything that makes this road safe for people who are walking?

You can also choose other ways to investigate a barrier. For example, you could talk to someone who has trouble moving around and discuss how that might be a barrier to making sustainable transportation choices. Or you could ask people about whether they feel safe on public transportation.

At the end of your investigation, think carefully:

- Are some groups more affected by barriers than others?
- How does that make you feel?
- What are the consequences of those barriers for encouraging people to switch to more sustainable transportation choices?

4. Carry out the investigation or investigations you decided to do.
5. When you have finished your investigations, stop and consider whether you would like to add any information to your *Energy Source Cards*. For example, you may have noticed some positive and negative effects of certain sources of energy.
6. Find a safe place to keep any data you recorded during your investigations. You will share it with your classmates in the next activity.
7. Read Felipe's thoughts about why it is so important to switch to sustainable sources of energy for transportation. Did you notice any of the effects he talks about in your investigations?

Felipe Says . . .

One of the reasons we have to work really hard on using sustainable energy for transportation is our health. Using high-carbon energy sources can produce **particulate matter**. Particulate matter can negatively affect the health of our lungs.

The second reason we have to work really hard on using sustainable energy for transportation is climate change. Electrifying transportation will help us fight against climate change. We need to adapt and be resilient to the consequences of climate change that are already happening in the world.

Act: *What do I want to change about transportation in my community?*

In the Discover activity you described how you and people in your household use transportation in your community. You also thought about what worries you. In the Understand activity you carried out investigations to find out more about how your community uses transportation, what sources of energy are used, and what's unfair about transportation. In this activity, you'll use all this data to figure out what you want to change about transportation in your community.

1. Get out your *How We Use Transportation* document from the Discover activity.
2. Get out the data from your investigations in the Understand activity.
3. Use the data and information from your *Energy Source Cards* to answer these questions on your own:
    a. What do I want to keep the same about transportation in my life? What do I want to keep the same about transportation in my community?
        - For example: "I use the city bus to get to school and to see my friends. Even though the buses use gasoline, I still want to be able to use the bus. It's the only way I can get around."

b. What am I most concerned about and want to change?
    - For example: "My neighborhood is near a big highway. It's loud and the air seems dirty. My family can't afford a car, but there are very few sidewalks, so walking isn't easy either. My sister uses a walker and it's really hard for her to get from place to place safely. I wish there were more buses and trains in our neighborhood."

4. Record your answers. You will share them with your team.
5. Gather as a team.
6. Share your answers from step 3.
7. Make a list of what you want to keep the same and what you want to change about transportation in your community.
8. Examine your list. What perspectives do you notice? Remember that you learned about social, economic, environmental, and ethical perspectives in Part 2. You can use your *Perspectives Chart* or your *Sustainable Energy Statement* to help you. Some examples are listed here:
    a. Social: I want transportation to be able to help me visit my friends.
    b. Economic: I need public transportation because I can afford it.
    c. Environmental: I'm worried about the air pollution near the highway.
    d. Ethical: It's not fair that my sister can't get around with her walker.
9. Read Felipe's perspective on switching to sustainable transportation. He discusses why it is important to use electric vehicles and make sure that electricity comes from sustainable energy sources. Do you want to include his perspective in your list of concerns?

Felipe Says . . .

In Bogotá around 70% of energy comes from **hydroelectric** power. So when I was helping Bogotá switch to electric buses, I didn't have to think about how to also switch to low-carbon sources of electricity.

But in my new job I think about problems all around the globe. Not every community has low-carbon sources of electricity. Some people come to me and say, "Hey, if we try to build an all-electric transportation fleet in a place where the source of electricity is 70% coal, we will harm the environment, so we should not try to electrify a fleet of vehicles." My perspective is that we have to do both. If we don't try to build an electric fleet *and* use low-carbon sources of electricity, we are going to face a really huge problem.

10. Which perspectives feel the most important to include?
11. Examine your list again. Is there anything you want to remove from the list, based on which perspectives you think are most important?
12. Keep this list of what you want to keep the same and what you want to change about transportation in your community in a safe place. You will need it in the Task 2, Act activity.

Task 2: How can we make transportation more sustainable?

In this task you will ***discover*** your **hopes** for sustainable transportation in your community. Then you will use investigations to ***understand*** how you could use the Avoid, Shift, and Improve **strategy** in your community. Finally, you will ***act*** by designing an updated transportation system in your community that reflects what you learned.

Discover: *What do I want transportation to be like in the future?*

Remember that in Part 1, Task 1, Discover you made a *Futures Mood Board* with your hopes and concerns for the future. You are going to use that same creative thinking in this activity and consider your hopes for transportation in your community.

1. Read *Avoid, Shift, and Improve*.

Avoid, Shift, and Improve

The **United Nations** uses a strategy called Avoid, Shift, and Improve to imagine a more sustainable future for transportation.

Avoid: This means reducing the *amount* of transportation people use. This could mean adding safe and accessible sidewalks to the roads or placing grocery stores close to people's homes. Or it could mean making some jobs **telecommute** jobs that don't require travel to an office.

Shift: This means making changes to the *kinds* of transportation people use. For example, choosing transportation that uses energy from people, such as rolling, walking, or bicycling, or transportation that uses sustainable sources of energy, such as electric vehicles or ships that use biofuels. Or it could mean using public transportation or ride-sharing.

Improve: This means making changes to *how* we provide transportation to communities. For example, making transportation more accessible to people in **rural** areas or to people with disabilities. Or it could mean improving the battery life of electric vehicles.

2. Examine your list of what you want to keep the same and what you want to change about transportation in your community from the Task 1, Act activity. If money, time, and the laws or rules of your community didn't matter, how would you use Avoid, Shift, and Improve to make transportation more sustainable in your community? Use your imagination and think big. Don't worry about making a perfect plan. Think quietly to yourself about the following questions and record your answers:
    a. How would you help your community *avoid* transportation that uses energy sources that are not sustainable?
    b. How would you help your community *shift* to using transportation that uses more sustainable energy sources?
    c. How would you help *improve* transportation in your community?
3. Discuss your answers with your team.
4. Read about Felipe's example of how improving transportation may also improve **gender equity**. Gender equity is fairness for all people, no matter their gender. Would you want to make a similar improvement in your community?

Felipe Says . . .

Switching to electric vehicles creates an opportunity for gender equity. Women may not have been using the bus before because they were feeling harassed or unsafe. Training women to drive electric buses creates a very positive cycle in which women are able to work in a **male-dominated** industry, but also, you create the opportunity for other women to use public transportation safely.

5. Take out your *Futures Mood Board*.
6. Stop and consider if you want to add any of your answers from step 2 to your *Futures Mood Board* in the *Hopes* section. Add them now.
7. Keep your answers from step 2 in a safe place. You will use them later in this task.

Understand: *How can our community make sustainable choices for transportation?*

Remember that you learned about the Avoid, Shift, and Improve strategy in the Discover activity. In this activity, you will apply what you learned using investigations into transportation in your community.

1. Gather as a team.
2. Read *Avoid, Shift, and Improve Investigations*.
3. Decide which investigation each team member would like to do. You can do more than one investigation. You can work by yourself or with others.

Avoid, Shift, and Improve Investigations

Avoid

You are going to investigate whether your community could avoid using non-sustainable types of transportation.

a. Think about the places in your community that meet your needs and how you get to those places.
   - You can use the *How We Use Transportation* document from Task 1 to help you remember.

b. Pick one place you get to using transportation that uses energy sources that are not sustainable. For example, a place you get to using a ferry powered by diesel or a car powered by gasoline.

c. Find a way to observe, examine a map, or make a map of the **route** you take to get to this place. For example, you could move along the route yourself and make observations directly, look at an online map of the route, or draw a map from memory.

d. Examine this route as you think about the following questions:
   - Is there a place closer to me where I can also meet this need?
   - Could I meet this need at home using the phone or Internet?

e. Record your answers. You will need them in the Act activity.

Shift

You are going to investigate whether your community could shift to more sustainable ways of transportation.

a. Think back to Task 1, Understand, Investigation 2: Energy to Transport People in Our Community. If your team did not complete this investigation, you can move on to step d.
b. Compare the number of vehicles with one passenger to the number of vehicles with more than one passenger. Which number was larger?
c. If the number of vehicles with one passenger was larger, what could your community do to encourage people to ride-share? Research the following questions:
    - Does your community offer people money to ride-share? Sometimes this is called a **credit** or **subsidy**.
        - Are there lanes in the road that are just for vehicles that are ride-sharing? Sometimes these are called **high-occupancy-vehicle lanes**, or HOV. HOV lanes help people move quickly from place to place when there is a lot of traffic.
        - Are there any advertising campaigns on the radio, television, or social media encouraging people to ride-share?

Figure 5.6: This high-occupancy-vehicle lane requires at least three people in a vehicle.

d. If your team did not complete Task 1, Understand, Investigation 2, consider whether your community could shift to using electric vehicles. Research the following questions:

   - Does any place in your community sell or rent electric vehicles, such as cars, bikes, or scooters?
   - Can people in your community afford to buy or rent an electric vehicle? How does the cost of an electric vehicle compare to the average annual salary in your community?
   - Does the local government offer money if you buy or rent an electric vehicle? Sometimes this is called a credit or a subsidy.
   - Are there lanes in the road or parking spaces that are just for electric vehicles?
   - Are there any electric vehicle **charging stations** in your community?

e. Record your answers. You will need them in the Act activity.

Improve

You are going to investigate whether your community could improve the affects transportation has on people.

a. Think back to Task 1, Understand, Investigation 3: Transportation, Energy, and Barriers. If your team did not complete this investigation, you can skip this section.
b. Think about the observations you made. What barriers are people in your community are experiencing?
c. Choose one of those problems to explore in this investigation.
d. Make observations, do research, carry out surveys or interviews, or use another method to collect more information about the problem. For example:

   - Investigate what public transportation options are available to reduce traffic, noise, and air pollution on highways and busy roads. If those roads already have public transportation, do a survey in your community to ask people what would make them more likely to use the public transportation on those roads, such as more stops, more **frequency**, or lower costs. You

could also ask if they ever worry about what their social group thinks of using public transportation and if that affects how often they use it.

- Carry out a survey in areas that have the fewest kinds of public transportation. Ask people what kind of public transportation would be the most helpful to their area and why.
- Investigate the areas that have very few or no sidewalks or bike lanes. Contact your local government, a local construction company, or a group in your community that **advocates**, or supports and encourages, sidewalks and bike lanes. Ask why the sidewalks and bike lanes are not there now. Find out how much it would cost to build them. Find out if there are any laws, policies, or rules that would prevent the sidewalks and bike lanes from being built.

e. Record your answers. You will need them in the Act activity.

4. Carry out the investigation or investigations you decided to do.
5. Keep your observations and information in a safe place. You will use them in the Act activity.

Act: *How can I help make transportation in our community more sustainable?*

In this activity, you will combine the information you imagined from the Discover activity with the information you collected in the Understand activity. You will use this information, as well as some of your ideas from Task 1, to **redesign** your community's transportation to be more sustainable.

1. Gather as a team to make a plan to redesign a part of your community's transportation system to be more sustainable. Just as you did in the Discover activity, use your imagination and do not worry about making a perfect plan. Do not worry about money or time.
2. Start by examining your team's list of what you want to keep the same and what you want to change about transportation in your community from the Task 1, Act activity.

a. What did your team want to keep the same about transportation in your community?

b. What were the most important things to change?

3. Examine the information you imagined in the Discover activity and the information you collected in the Understand activity in Task 2. You will use that information to think about solutions to the problems in your community. Record your answers to the following questions:

   a. What solutions can you think of for the things you want to change about transportation in your community?

   b. Could you avoid, shift, or improve transportation in some way?

Figure 5.7: This road is just for people using bicycles. It helps keep the people on bicycles safe from cars and encourages them to use sustainable transportation.

4. Examine your team's answers from step 3 on your own. Think about the four perspectives: social, economic, environmental, and ethical. Consider your answers from step 3 from these four perspectives. Is there anything you want to change about or add to your answers? For example:

   a. Economic and Ethical: Your team wants to redesign your community to include more lanes and charging stations for electric vehicles. But you observed that the people who earn the least money in your community cannot afford electric vehicles. They also live in areas with the least public transportation. What might be a better solution to help make transportation more affordable and more fair for people who earn the least money in your community?

5. Gather as a team again.
6. Share your answers from step 4 with your team. Add to or change your solutions and ideas from step 3, if needed.
7. Choose one or two of the solutions or ideas from step 3 to use in the rest of this activity.
8. Make a model of how you would redesign transportation in your community, based on one or two of the solutions your team thought of in step 3. For example, you could redraw a map of a busy road with high-occupancy-vehicle lanes. You can make a model in several ways:
    a. Use paper or an online document to make a map.
    b. Make a list of steps or a description.
    c. Make a video or audio recording of transportation in your community.
    d. Make a paper or digital collage of photos of transportation in your community.
    e. Make a three-dimensional model using building blocks, discarded items, or other things that are easy for you to find.
9. Think back to the Task 1, Discover activity. You might have communicated with people who did not want your community's transportation to change. How would you communicate your plan to redesign transportation to these people? What could you say to convince them?
10. Get out your *Futures Mood Board* and add any helpful information from this task.

Congratulations!

You have finished Part 5.

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.

Access: Able to easily reach

Accessible: Able to easily reach or use a place, thing, or idea

Advocate: To recommend or support

Aircraft: A form of transportation that moves people or things through the air, such as an airplane or helicopter

Avoid: To keep from doing

Charging station: Where a person can recharge anything that stores electricity in a battery, such as a car or a mobile phone

Climate change: Changes in the patterns of temperature and precipitation on Earth

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

Concern: Something that causes anxiousness, worry, or fear

Credit: Money or the promise of money given to a person

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

Economic: About money, income, and the use of wealth

Emission: Material that is sent into the air, such as exhaust from a car

Energy: Anything that gives the ability to do work

Environmental: About the natural world

Equitable: Treating all people fairly

Equity: Fair treatment of all people

Ethical: Something that is fair

Fleet: A group of vehicles

Frequency: The number of times something happens

Gender equity: Fairness for all people, no matter their gender

Greenhouse gases: Gases such as carbon dioxide and methane that cause the atmosphere to get warmer

Heavy duty vehicle: Vehicles that typically move large numbers of people or amounts of things, such as large vans, large pickup trucks, tractor-trailer trucks, garbage trucks, cement trucks, or buses

High-occupancy vehicle lane: A road lane that can only be used by vehicles with more than one person inside, sometimes abbreviated as HOV

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

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

Identity: The characteristics that make you you

Improve: To make better

Inclusive: Making sure no one is left out

Light-duty vehicle: Vehicles that typically move small numbers of people or amounts of things, such as cars, motorcycles, auto-rickshaws, motorized tricycles, minivans, or smaller pickup trucks

Male-dominated: Something that is used or controlled mostly by men

Off-road vehicle: A vehicle that moves people or things in areas without roads, such as tractors, bulldozers, all-terrain-vehicles, mining equipment, or ride-on lawn-mowers

Particulate matter: Small airborne particles, such as pollen, dust, or smoke

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

Pessimism: Expecting things to go badly or expecting the worst outcome possible

Pipeline: A form of transportation that moves liquids over a distance using a large pipe and pumps

Rapid transit: Transportation that moves many people very quickly, especially in urban areas

Redesign: To design again with the hopes of improving the original design

Route: The way you move from place to place

Rural: A place with low housing density, like the countryside

Shift: To change

Social: Relating to the interaction of people in a community

Strategy: A plan or way of doing something

Subsidy: When the government gives someone money to encourage them to do something for the public good

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

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

Telecommute: To work from a place other than an office or job site, using tools such as phones and computers

United Nations: A global organization designed to help governments and people around the world collaborate

Urban planning: Figuring out how to best use the space in a city or town

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ENERGY!

Part 6:

Energy to Use and Make Things

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian
Science Education Center

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

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PART 6: ENERGY TO USE AND MAKE THINGS

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 power things in our daily life?					
Discover	Reflect on how you use energy in your daily life.	• Paper • Pens or pencils • Watch, clock, or other way to know the time		30 minutes + interview time	172
Understand	Investigate energy efficiency and energy conservation using items from your daily life.	• Paper • Pens or pencils • Internet (optional) • Calculator (optional)		35 minutes	175
Act	Calculate the cost of using items in your daily life and how energy efficiency or energy conservation could help you reduce costs.	• Paper • Pens or pencils • Calculator (optional)		30 minutes	179

Activity	Description	Materials and Technology	Additional Materials	Approximate Timing	Page Number
Task 2: How can we make industry more sustainable?					
Discover	Examine data about greenhouse gas emissions in several kinds of industries.	• Calculator (optional)		15 minutes	183
Understand	Read about how industry uses energy to do work. Then investigate the industries in your community and collect information about the people who are the most affected by these industries.	• Paper • Pens or pencils • Internet (optional) • Online or paper map (optional)		15 minutes + investigation time	185
Act	Analyze the data from your investigation and identify the kinds of actions you want to take.	• Paper • Pens or pencils	*Energy Source Cards* *Futures Mood Board*	25 minutes	191

Meet Your Research Mentor

Meet Lincoln Bleveans. Lincoln (pronounced *LINK-uhn*) will be your research mentor to help you understand how **energy** helps people use things and make things.

Lincoln is the executive director of sustainability and energy management at Stanford University in the United States. He has a bachelor's degree in Chinese, Japanese, and French and a juris doctorate in commercial and international law. Lincoln has worked in the energy industry for more than 30 years and has special expertise in electric power, energy efficiency, and sustainability.

However, he also has knowledge and **perspectives** that come from other parts of his **identity**. Since Lincoln is now working with you, it is important to understand who he is.

Lincoln's Identity Map

- White male
- 56 years old
- Lives in California in the United States
- Is bald, has a beard, and wears glasses
- Has the roles of father and husband
- Is funny
- Enjoys reading
- Likes to podcast
- Likes to surf
- Is both introverted and extroverted
- Is inclusive
- Interested in behavior and languages
- Interested in history and **paleoanthropology**
- Considers himself the ultimate "square peg" in his job

Task 1: How do we use energy to power things in our daily life?

In this task you will ***discover*** how you use energy to **power** the things in your daily life. You will carry out an investigation to ***understand*** how people can reduce the amount of energy they use. You will use calculations and examine perspectives to figure out how you want to ***act*** to reduce personal energy use in your **community**.

Before you begin the rest of Part 6, think quietly to yourself about Lincoln's identity map.

- Are there things you have in common with Lincoln?
- Are there ways in which you are different from Lincoln?
- Can you see anything about Lincoln's identity that makes it easier for him to think about how to use **sustainable** energy to use things or make things?

During Part 6 you will notice Lincoln sharing ideas and experiences with you. He may help you understand better ways to conduct investigations, or he may share some of the work he has done.

Discover: *How do I use energy in my daily life?*

What kinds of items do you use every day? You might be thinking of things like a clock, a cooking surface, a sink faucet, lights, a computer or mobile device, or a radio. All of these items need energy to work. In this activity, you and your team will reflect on how important energy is to your daily life and what kinds of items help you meet your needs.

1. Read *My Energy Reflection* and complete the activity the next time you wake up in the morning.

My Energy Reflection

a. Put a piece of paper and a pen next to where you sleep. You can also choose another way to record information. Also place a clock, watch, mobile phone, or another way to record the time next to where you sleep.
b. Go to sleep.
c. When you wake up, record what time it is.
d. Begin your day. Notice the first time you use something at home that requires energy.
e. Record what time you use that item. (Do not worry about recording what time you used your clock in step c, even though the clock uses energy. Just record the next item that requires energy.)
    - For example, you may use your mobile phone to check for messages from friends. Or you may turn on a light. Or you might take a hot shower. Or you might heat up a cooking surface to help prepare your family's first meal of the day.
f. Reflect on how that item has helped you meet your needs. Record your answer.

2. Gather with your team.
3. Make a timeline. Mark what time each teammate woke up using a mark, color, symbol, or note. Use a different mark, color, symbol, or note to mark what time each teammate first used something at home that requires energy. Figure 6.1 has an example.

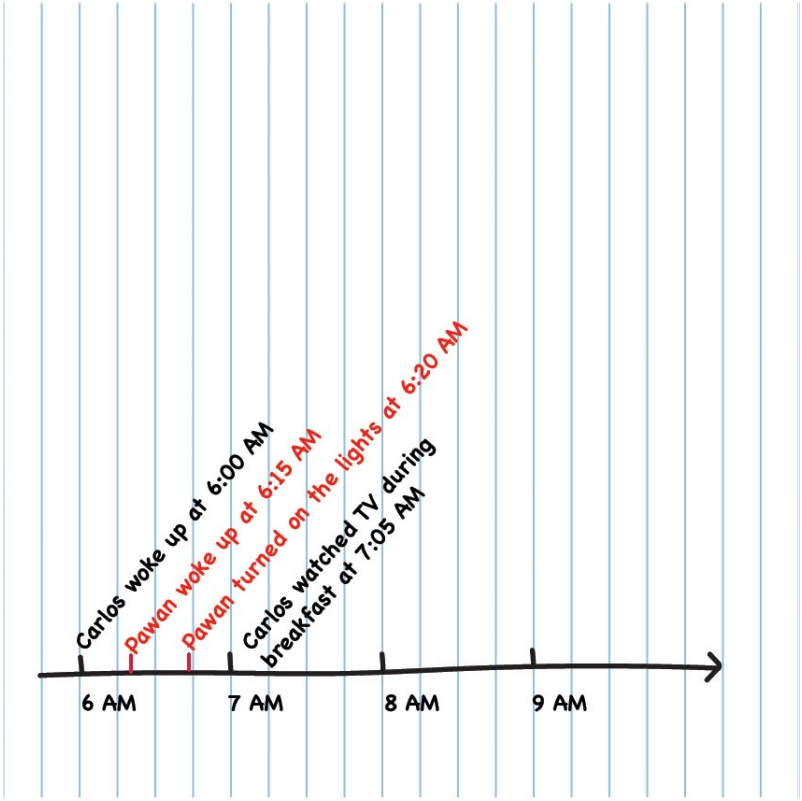

Figure 6.1: Example of a team timeline.

4. Record on the timeline what item each team member used and how it helped them.
5. Discuss as a team:
    a. What was the shortest amount of time it took to use something that requires energy? What was the longest amount of time?
    b. What surprised you about your team's timeline?
    c. What does this timeline tell you about how you use energy in your daily life?

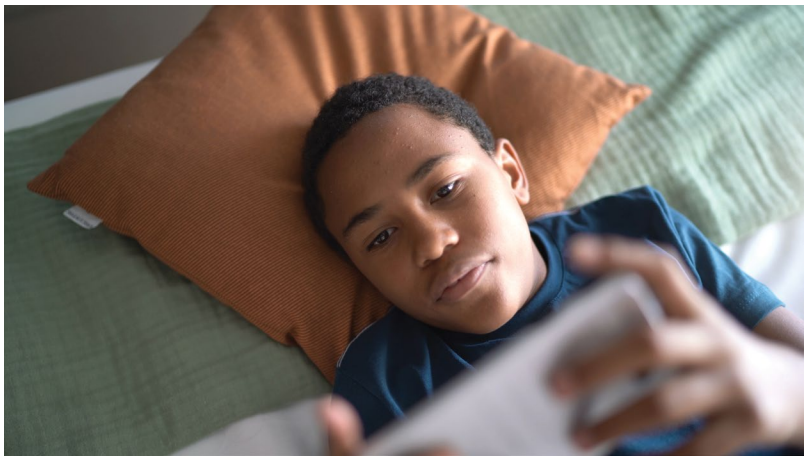

Figure 6.2: This young person uses their mobile phone as soon as they wake up.

6. If you have the time, you can ask other members of your household to do the *My Energy Reflection* activity and add their information to your team timeline. As a team, discuss the same questions from step 5.
7. Keep your timeline in a safe place. You will need it in the Understand activity.

Understand: *How can people in my community reduce the amount of energy we use?*

In the previous activity you discovered how you and your team use energy every day and how that energy helps you meet your needs. You know that one way to create a more sustainable energy future is avoid energy sources that produce a lot of carbon. To accomplish that, you can shift to use lower-carbon and more sustainable sources of energy. You can also try to reduce the amount of energy you use per day.

In this activity, you will conduct investigations that help you figure out how to use **energy efficiency** and **energy conservation** to reduce the amount of energy you use in your daily life.

1. Think about what item you recorded in the *My Energy Reflection* activity. Answer the following questions on your own:
   a. How would your life be different if you could *not* use this item?
   b. Do you think you could make a choice to use this item *less often*? Why or why not?
2. Read *Energy Efficiency and Energy Conservation*.

Energy Efficiency and Energy Conservation

Energy efficiency is a term that describes items or processes that use less energy to do the same tasks. For example, an energy-efficient refrigerator has improved **technology** that enables it to keep food cool using less energy than a regular refrigerator.

Energy conservation is a term that means changing your behavior to use less energy. You might try to stop using an item or use it less than you did before.

Figure 6.3: These light bulbs are energy-efficient. They are light-emitting-diode bulbs, *or LEDs. They can provide the same amount of light as an* incandescent bulb, *but they use much less energy.*

3. 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. Read what he says about how the Smithsonian Institution works to conserve energy and make appliances more efficient in its kitchens.

"Many kitchens use constant-volume **grease hoods**. This means you turn the fan on in the morning and it stays on until the end of the day. The grease hood helps move greasy vapors and harmful gases to the outside of the building. We have now installed a variable volume-hood at the National Museum of African American History and Culture. Variable-volume hoods have heat and smoke sensors to help them tell when someone is cooking. When someone is cooking, the hoods run at 100%. When no one is cooking, the hoods switch to 30% power. This saves energy."

4. Read Lincoln's thoughts about how people's behavior can affect sustainable energy use. What behaviors do you think people can change about the energy they use?

Lincoln Says . . .

In my industry, people tend to get so excited about new technology and **innovation**. But what we're finding is that behavior change is the secret. Technology is cool, but it doesn't make a difference without the behavior change.

5. Gather as a team.
6. Read *How Can I Use Less Energy in My Daily Life?* You can work by yourself or with others to complete the investigation.

How Can I Use Less Energy in My Daily Life?

Remember what you read in *Energy Efficiency and Energy Conservation*. This investigation will help you or your team members think about how you can use energy efficiency and energy conservation in your daily life. You are going to examine up to three of the most important items you use each day, either at home or at school. You will then think about how you can reduce your energy use by either changing the item you use or the way you use it.

a. Get out a piece of paper or choose another way to record information.
b. Make a table like the one in Figure 6.4.
c. Think about some of the most important items you use every day. For example, items you use the most often or that help you meet your needs.
d. In the column titled *Item name* list up to three of the most important items you use every day. Each item should get its own row. You can use the item you recorded in the Discover activity if you think it is one of the most important.
e. In the column titled *How much energy does it use?* follow these steps to help you calculate how much energy this item uses:

   - Examine the item to see if it lists how many **watts** it uses. Watts are a measure of power. For example, you might find a label that reads "60 watts." If the watts are not listed on the item, use the Part 6 StoryMap to help you find other ways to calculate the watts for that item.

- Figure out how many hours a day you use this item. Some items you may use for only a few minutes and other items may stay on for 24 hours a day. Use a decimal if you need to show you use an item less than a full hour. For example, if you use an item for 30 minutes, that is 0.5 hours.
- Calculate the **Kilowatt-hour (kWh)** daily use for this item. Daily kWh is a way of measuring how much energy an item uses each day. You can calculate kWh using this equation along with the watts and hours of use you just gathered: Daily kWh= (watts × hours used per day) ÷ 1,000
- If the item does not use electricity, try to find another way to estimate the amount of energy it uses. For example, if you are using a natural gas stove to cook, measure how many minutes it takes you to cook. Or if you are using firewood, measure how many sticks you need to cook.

f. In the column titled *Could I use a more energy-efficient item?* investigate to search for another, more energy-efficient item to meet your needs. Some items come with a label that tells you they are energy-efficient. You can also do research on the Internet or ask a person who works in a shop that sells these kinds of items. Consider why you might or might not be able to get this kind of item. Does it exist? Can you afford it? Is it for sale in your community?

g. In the column titled *Can I use this item less?* consider whether you could use this item less often. Explain your reasoning.

h. Leave the column titled *What perspectives should I consider?* blank for now. You will complete that in the Act activity.

Item name	How much energy does it use?	Could I use a more energy-efficient item? Why or why not?	Can I use this item less? Why or why not?	What perspectives should I consider?
Lamp and light bulb. I think the bulb is incandescent.	60 watts of electricity x 4 hours a day ÷ 1,000 = 0.24 kWh	I could use a different kind of bulb. I heard that LEDs use 90% less energy than a regular incandescent bulb. But these bulbs are more expensive.	I need this light to do my homework at night. But I could go into my brother's room at night, since he is also using a lamp. Then we won't have two lamps on at once.	

Figure 6.4: Example of a table for recording data about items that use energy.

7. Keep your table in a safe place. You will need it in the Act activity.
8. Read Lincoln's thoughts about energy efficiency and energy conservation. He uses the example of energy use in California in the United States. Do you think you should do the same things to save energy in your area, or is your situation different?

Lincoln Says . . .

Here in California, we have a lot of solar power and generate a lot of electricity in the middle of the day. If we are going to hit 100% renewables or close to it, that means nighttime energy has to be renewable too. You can only build so much storage. And there's only so much wind and geothermal that will produce at night. Using this energy in the right way means changing 100 years of behavior. So if everybody charges their cars at night, that is a problem. How do we create incentives and **infrastructure**, so that everybody's like, "Oh, sun's out. I'm plugging in."

Act: *What do I want to change about how people in my community use energy?*

In this activity, you will calculate how energy conservation and energy efficiency can help you reduce the amount of energy you use and reduce the cost of using that energy. You will also examine how **economic**, **ethical**, **environmental**, and **social** perspectives affect the decisions you make about energy conservation and energy efficiency.

1. As a team, examine your *How Can I Use Less Energy in My Daily Life?* table from the Understand activity.
2. Each person should choose an item they were able to calculate the kWh for. If there are not enough of those items, it is okay to work together and share an item.
3. Make a note of the daily kWh of your item. You will need this in the next step.

4. Find out on your own how expensive it is to use each item. Use the following information to help you:
    a. Find out how much each kWh of power costs in your home or school. This information may be on a utility bill, or you can ask an adult or use the Internet to look up your average local cost of each kilowatt-hour. This is your **utility rate per kWh**.
    b. Use this equation to calculate the daily cost to use your item:

        Cost = daily kWh × utility rate per kWh

5. Calculate how expensive it would be to use this item if you:
    a. Reduced the number of hours a day you used the item (energy conservation). Use the following equations to calculate the new cost:
        - Daily kWh = (watts × hours used per day) ÷ 1,000
        - Then use your new daily kWH to calculate the new cost:

            Cost = daily kWh × utility rate per kWh
    b. Use an energy-efficient item instead. For example, an older washing machine might use 1,400 watts per wash cycle but a more energy-efficient one might use 400 watts. If you know the wattage for a more energy-efficient item, you can use the equations from step 5a to calculate the new cost.

*Figure 6.5: This person has purchased an energy-efficient **heat pump** to heat and cool their home.*

6. In the column titled *What perspectives should I consider?* think about the social, environmental, economic, and ethical perspectives that might affect your decisions. For example, here are some questions you might want to consider when thinking about decisions related to different types of items:
    a. Social: How might your relationships change if you stopped using a mobile phone to communicate with others?
    b. Environmental: Could you reduce your impact on the environment if you switched from using natural gas to electric for cooking?
    c. Economic: Can you, your household, or your school afford to purchase a new energy-efficient item?
    d. Ethical: Is it fair to ask someone to use an item less if they need it to meet their needs?

Item name	How much energy does it use?	Could I use a more energy-efficient item? Why or why not?	Can I use this item less? Why or why not?	What perspectives should I consider?
Lamp and light bulb. I think the bulb is incandescent.	60 watts of electricity x 4 hours a day ÷ 1,000 = 0.24 kWh	I could use a different kind of bulb. I heard that LEDs, or light-emitting diodes, use 90% less energy than a regular incandescent bulb. But these bulbs are more expensive.	I need this light to do my homework at night. But I could go into my brother's room at night since he is also using a lamp. Then we won't have two lamps on at once.	Economic: I don't know if my parents can afford to buy energy-efficient light bulbs. Social: It is easier to do my homework alone in my own room.

Figure 6.6: Example of a table for recording data with the perspectives column filled in.

7. Read Lincoln's thoughts about why it is important to think about economic perspectives when encouraging people to use energy more sustainably. What should your team think about when planning changes in your community?

Lincoln Says . . .

Some people say, "Let's use sustainable energy for everything right now!" But that process can be expensive. Expensive energy is okay if you have plenty of money, but if you do not, it can be devastating. For example, many Americans already make a monthly decision between paying for food and paying their utility bills. We must switch to sustainable energy, but we have to also recognize that all of us are not living in nice houses and paying our energy bill without a thought. Energy costs in general drive food decisions and health care decisions, and that's just in the United States!

8. As a team, read through your *How Can I Use Less Energy in My Daily Life?* tables. Think about how you could make changes to the way you use those items. Which changes do you think would make the biggest difference to energy use in your community?
9. Get out your *Futures Mood Board*. What **hopes** or **concerns** from this task to you want to add? Add them now.

Task 2: How can we make industry more sustainable?

People use energy to make things we need and use. The process of making things is called **industry**. Industry can include processes such as **mining**, **agriculture**, **manufacturing**, **construction**, and making materials such as metals, paper, and **chemicals**. All industries use energy to do work. In fact, industry is one of the largest **consumers** of energy in the world. Right now, much of that energy comes from **fossil fuels**.

In this task you will ***discover*** how industry uses energy and what impact that can have on your local area and the globe. You will ***understand*** how energy sources and energy use in industry can affect people in your community. You will ***act*** to come up with ways you can make industry more sustainable and **equitable** in your community.

Discover: *What do I think and feel about how industries use energy?*

In this activity, you are going to examine some **data** about the amount of **greenhouse gas** emissions that come from several kinds of industry around the world. Greenhouse gases are gases that cause the atmosphere to get warmer. Carbon dioxide is the most common greenhouse gas produced by human activities, but there are others, too, such as methane. The **low-carbon** or zero-carbon energy sources you have learned about produce little or no carbon dioxide.

1. Examine the following graph on your own.

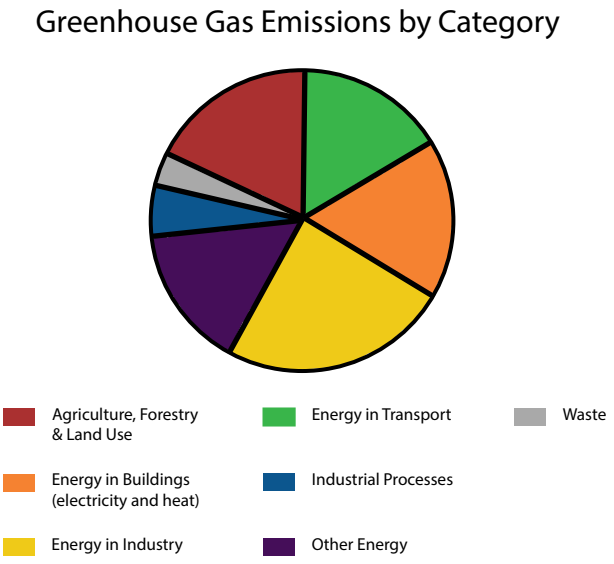

Figure 6.7: This graph shows the percentage of greenhouse gas emissions by category.[1]

2. Think about the following questions on your own:
    a. What do you notice about the graph?
    b. How do you feel about the information this graph shows?
3. Discuss with your team:
    a. Which category has the most greenhouse gas emissions?
    b. Why do you think there are so many greenhouse gas emissions from energy used in industry?
    c. Why would it be important to know the information in this graph if you were thinking about reducing the greenhouse gases released into the atmosphere?
4. Examine your *Energy Source Cards*. More than half the energy used in industry produces greenhouse gases. Which energy sources might be used more often to generate that electricity?
5. Consider you other *Energy Source Cards*. Are there low-carbon or zero-carbon energy sources and that might be able to replace fossil fuels that release a lot of greenhouse gases?
6. With a partner, have one partner pay attention and have the other partner share.
7. As the sharing partner, pick a sustainable energy source and imagine you were trying to convince a company to change their source of energy. Share with your partner why you think this change might be important and why you picked this energy source.
8. Switch roles and have the other partner share information about a different energy source.
9. Discuss with your partner:
    a. If you were a business or company owner, what might convince you to change?
    b. Are there certain things you would need from your energy source? For example, maybe it is really important that energy is reliable if you are using it to manufacture things.

Understand: *What industries are in my community and who do they affect?*

You are going to investigate which industries are located in or near your community. You will also gather information about the kind of energy sources they use. This investigation will help you figure out who in your community is most at risk of harm from energy use in industry. The data you collect can help you create a more equitable future for your community. The data can also help you figure out where in your community you should **advocate** for using more sustainable sources of energy.

1. Read *Energy in Industry*.

Energy in Industry

Across the world, 68% of the energy used in industry currently comes from fossil fuels. Fossil fuels are a not a sustainable form of energy, and using fossil fuels produces greenhouse gases. These greenhouse gases change Earth's climate. This is a problem both for people and other living things on the planet. This section will help you understand how energy is used to power certain processes in industry.

Powering Machines and Vehicles

Energy is needed to power machines that perform a variety of jobs in industry. In mining, energy is needed to power drills, dig tunnels, move materials from a mine to the surface, and dig up materials on the surface. Mined materials are used in many products, such as mobile phones. In agriculture, vehicles and machines use energy to plant, water, and **harvest** crops. In manufacturing, machines use energy to put parts of products together or seal them in a package.

Fossil fuels, including fuels created from **petroleum (oil)**, such as gasoline, are often used to power these machines and vehicles or to generate the electricity that powers them.

How can powering machines and vehicles be more sustainable? Industries can use electric vehicles or vehicles that run on **biomass** instead of gasoline. Fuels can

be created from biomass sources such as wood, algae, corn, or fat. Sustainable electricity from low-carbon sources can be used to power vehicles and machines, instead of fossil fuels.

Figure 6.8: This plant uses machines to assemble cars.

Making Heat

Some industries need heat to make products. For example, cement is made by heating limestone to a very high temperature in a **kiln**. Steel, paper, chemicals, and certain kinds of food are also made using large amounts of heat. When fossil fuels are burned to produce heat, they release carbon dioxide and other harmful chemicals into the air, which can affect the air quality and the health of nearby communities.

How can making heat be more sustainable? Industries can use **solar**, **geothermal**, or biomass energy to produce heat. Electricity from low-carbon energy sources can also produce heat.

Supplying Feedstocks

Sometimes energy sources are used as **feedstock**. In industry, feedstock is any material can be turned into something else. Fossil fuels such as coal, natural gas, and petroleum can be turned into products such as tires, medicine, cosmetics, plastics, fertilizer, clothing, and detergent.

How can making these products be more sustainable? Industries can use leftover or recycled materials, such as recycled plastic, to make products instead of using fossil fuels. Industries can also use biofuels to make certain kinds of products

instead of fossil fuels. People can also stop using or reduce how often they use products that come from fossil fuel feedstock. If you are interested in finding out more about bioplastics and other more sustainable materials, please explore the *Biotechnology!* guide.

2. Gather as a team.
3. Read *Investigation of Industry in My Community* and carry out your investigation.

Investigation of Industry in My Community

You and your team are going to meet two goals with this investigation:

- Investigate what kinds of industries are in or near your community and how they use energy to do their work.
- Investigate who in your community is most at risk of harm from these industries.

What kinds of industry are in my community?

Decide on How to Gather Information

Decide how you will gather information about the kinds of industry in your community. You can:

a. Move around your community and directly observe any buildings or locations that have a kind of industry.

⚠ Physical Safety Tip

If you choose to move around your community to observe industry directly, be very careful. Some industries use dangerous chemicals, machinery, processes, or vehicles. Do not get too close to any buildings, locations, or areas without permission and an adult present. Many industries are on private property and do not allow visitors.

b. Examine a map of your community that has each building or site in the community labeled. You can use a paper map or go online and search for a digital map. Search for words such as "farm," "mine," "construction site," "steel mill" or "steel works," "manufacturing plant," "cement," "paper mill," "chemical plant," "food processing," "factory," and "industrial."
c. Use the Internet to do a search, using the terms in step b and the name of your community.
d. Ask adults in the community.
e. Ask your local government or council for a list.
f. Remember that you did a Community Energy Observation activity about places that use energy in Part 1. Review that investigation. Is there data you can use to help you in this investigation?

Decide How to Record Information

Decide how you want to record information about the kinds of industry in your community:

a. Make a new map or change an existing map so you can mark all the places in your community that have industry.
b. Make a written list of the places you find.
c. Make an audio or video recording of all the buildings and locations.

Pick an Industry

Each team member should pick one kind of industry in your community.

Try to find out what energy source each kind of industry is using and what it uses energy to do. Is it powering vehicles or machinery, producing heat to make something, or using energy sources as feedstock? It may be a combination of some or all of these. Here are some ways you could find out.

a. Communicate directly with each kind of industry and ask what kind of energy is used and what that energy is used for.
b. Use the Internet to research.
c. Ask adults in the community, especially adults that work in each kind of industry.
d. Ask your local government or council if they have information.

⚠ Emotional Safety Tip

It may be difficult to ask people about the industry they work in. Some people or companies are happy to share information, but others want to keep their information private, even to young people. You are not doing anything wrong by asking, but do not worry if you have trouble getting this information. Just do your best.

How could industry use energy differently?

a. If you can, figure out if the way the industry you investigated is using energy has any positive or negative effects on the community. For example, a positive effect might be that they are able to use renewable energy and create an example for the community. A negative effect might be they are wasting energy by leaving the lights on or creating pollution when they generate electricity. To find out more you could:

- Ask community members.
- Ask advocacy groups that protect people in at-risk communities.
- Check if your local or national government keeps records of air pollution and water pollution from industry.
- Remember that your team did a Community Effects Investigations in Part 1 about how energy affected your community. Review that investigation. There may be data that can help your investigation now.

b. With your team, think about the industries you investigated. To become more sustainable, industries could try to save energy or they could switch to a different energy source.

c. Turn to a partner and share how you think the industry you investigated could become more sustainable in their energy use.

d. If you thought they should save energy, share some ways you think they could do that. For example, maybe turning off the lights at night or using more energy-efficient equipment.

e. If you thought they should switch energy sources, take out your *Energy Source Cards*. Examine them and share with a partner which energy source you would choose to change to.

f. Switch roles.

g. Gather in a circle and discuss with your team, what are the barriers or reasons that industries have not changed? Go around the circle and list one barrier that might stop your industry from making the change you recommend. You can use social, environmental, economic, or ethical perspectives to help you think about barriers.

Figure 6.9: People living near mines may experience noise, dust, and vibrations from large mining machinery such as these trucks.

h. Go around the circle again and share how you might help a company overcome the barrier you identified.

If you would like to find out more about how industry may harm certain groups, you can use the *Environmental Justice!* guide to investigate further.

4. Keep your observations and information in a safe place. You will use them in the Act activity.
5. Read Lincoln's thoughts about the importance of using reliable, affordable, and sustainable energy sources. Discuss with your team: What industries in your community most help meet people's needs? What kind of reliable, affordable, and sustainable energy sources do you think they should consider?

Lincoln Says . . .

Energy in your community has to be reliable, affordable, and sustainable, because if you miss one of those things, it's not going to work. All the sustainability in the world doesn't matter if the electricity is not reliable and affordable, because the electricity can't be used. And affordability alone is not helpful if we can't rely on the power, let alone use it as a sustainable source of energy.

Act: *How can I help make industry more sustainable and equitable for my community?*

In this activity, you will use the data you collected from your investigation to examine energy equity in your community. How does energy use in industry affect the people in your community? Does it affect everyone equally? Who is most at risk? The answers to these questions will help you decide how you want to act to create a more sustainable and equitable energy future for your community.

1. Gather as a team.
2. Get out the information you recorded from your *Investigation of Industry in My Community*.
3. Discuss the following questions:
   a. What is the most common kind of industry in your community?
   b. What is the most common source of energy for industry? What is that energy used for?
   c. What information did you find out about the people who live nearby the industry in your community? Is there anything they have in common?
   d. How does industry in your community affect the people living there? Consider both the things that benefit your community and the things you might want to see changed.
   e. Who do you think is benefiting the most in your community? Who is most at risk?

4. As a team, discuss what kind of action you could take to make things better in your community. For example, you could:
    a. Find out who is in charge of **monitoring**, or watching over, how industry works in your community and share with them any concerns you have.
    b. Use the choices you make about what you buy to encourage companies to use sustainable energy sources.
    c. Share what you have learned with others, individually or in community meetings, so everyone can make more informed decisions.
5. Read Lincoln's thoughts about how you can attend community meetings to show that you care about issues related to sustainable energy. What meetings you could attend in your community?

Lincoln Says . . .

When I worked in city government, it was remarkable how much the decision-makers paid attention to the people who showed that *they* were paying attention. If you show up to a city council meeting and you say, "I'm worried about this in my community," you have made more of an impact than a thousand emails or a thousand phone calls. The fact that you're paying attention to a problem makes the decision-makers have to pay attention to the problem. That curiosity is, in fact, advocacy.

6. Get out your *Energy Source Cards*. What sustainable energy sources do you think could supply power to the industry in your community?
7. Get out your *Futures Mood Board* on your own. What hopes or concerns from this task to you want to add? Add them now.

Congratulations!

You have finished Part 6.

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.

Advocate: Try to advance an idea or cause

Agriculture: The practice of growing crops or raising livestock

Chemical: A substance that can occur naturally or can be made

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

Construction: An industry in which people build things such as homes or bridges

Biomass: Wood and other plant or organic materials

Concern: Something that causes anxiousness, worry, or fear

Consumer: One that uses something up

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

Economic: About money, income, and the use of wealth

Energy: Anything that gives the ability to do work

Energy conservation: Using an item or process less or not at all in order to save energy

Energy efficiency: Items or processes that use less energy to do the same amount of work

Environmental: About the natural world

Equitable: Treating all people fairly

Ethical: Something that is fair

Feedstock: Any material can be turned into something else in an industrial process

Fossil fuel: A type of fuel that comes from the fossilized remains of plants and animals

Geothermal energy: Heat from the Earth that can be used to generate electricity

Grease hood: A duct that removes greasy vapors to the outside of a kitchen or building

Greenhouse gases: Gases such as carbon dioxide or methane that cause the atmosphere to get warmer

Harvest: The process of gathering crops when they are ready to be picked

Heat pump: A device that transfers heat from a colder area to a hotter area; it can be an energy-efficient way to keep a building at a comfortable temperature

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

Identity: The characteristics that make you you

Incandescent light bulb: An older kind of light bulb that has thin wire filaments and gives off heat

Industry: The process of making things that people need, want, or use

Infrastructure: Built things that stay in your community (for example, bridges, buildings, train tracks)

Innovation: A new idea or method of doing something

Kiln: An oven that heats up to burn or dry a material or item

Kilowatt-hour (kWh): A measure of electricity defined as a unit of energy, measured as 1 kilowatt of power expended for 1 hour

Light-emitting-diode (LED) light bulb: A modern kind of light bulb that uses less power and produces less heat than an incandescent light bulb

Low-carbon: An energy source that releases very little carbon dioxide gas into the atmosphere.

Manufacturing: The process of making something from raw materials

Mining: To remove something valuable from the ground, such as a mineral

Monitoring: Keeping track of, responsible for, or watching

Petroleum (oil): A liquid non-renewable resource that forms when living things die, are covered in layers of dirt and rock, and are compressed

Paleoanthropology: The study of ancient human-like organisms and their descendants

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

Power: The rate at which electricity is transferred along a circuit

Social: Relating to the interaction of people in a community

Solar energy: A renewable and low carbon resource that converts light energy from the sun into electricity using solar panels or uses the heat of the sun to heat water or other substances

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

Technology: Materials and methods used to solve people's problems and fill their needs

Utility rate per kWh: The cost of 1 kilowatt of power expended for 1 hour

Watt: The unit of measurement for electric power

End Note

1. Ritchie, Hannah, and Max Roser. 2020. Global Greenhouse Gas Emissions by Sector. *OurWorldInData.org*. 2020. Retrieved from https://ourworldindata.org /emissions-by-sector

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ENERGY!

Part 7: Taking Action

SUSTAINABLE DEVELOPMENT GOALS

developed by

Smithsonian *Science Education Center*

in collaboration with

iap SCIENCE HEALTH POLICY
the interacademy partnership

Smithsonian Science Education Center greatly appreciates the efforts of all the individuals listed below in the development of *Energy! How can we ensure sustainable energy for all?* Part 7. Each contributed his or her expertise to ensure this project is of the highest quality. For a full list of acknowledgments, please refer to the acknowledgments section at the beginning of this guide.

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Science Curriculum Developer - Logan Schmidt

The contributions of the Smithsonian Science Education Center staff, Project advisors, research mentors, and technical reviewers are found in the acknowledgments section.

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Guide developer - Logan Schmidt

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PART 7: TAKING ACTION

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 will I help create a sustainable energy future?					
Discover	Use your *Futures Mood Board* to decide what future you want to take action to support.	• Paper • Pens or pencils	*Futures Mood Board*	20 minutes	203
Understand	Come to consensus and plan your action.	• Paper • Pens or pencils	*Identity Map*	45 minutes	206
Act	Implement your action plan and reflect on your action.		*Action Plan* *Futures Mood Board*	15 minutes + action time	208

Task 1: How will I help create a sustainable energy future?

As **action researchers** you now have a lot of information. You discovered what is important to you and your team. You understand more about the science of **sustainable energy**. You understand the values of people in your **community**. Now you will put those ideas together. In this part you will decide how your team will act to create the future you want. Then you will put those plans into action.

In this task you will ***discover*** more about your and your community's **hopes** for the future. Then you will ***understand*** more about your role in working toward those goals. Finally, you will ***act*** on your ideas and work toward a sustainable and positive future.

Discover: *How do I want my community to use sustainable energy in the future?*

Before you decide what you want to do, you need to think about what you want to accomplish. Many different futures are possible. Which one do you want to work toward?

1. Take out your *Futures Mood Board*.
2. With your team, think about everything you have learned in this guide. Is there anything you would like to add to your *Futures Mood Board*? If so, add it now.
3. By yourself, examine the *Futures Mood Board*. Pick one part of the future that relates to sustainable energy that you would like to work toward. It could be a **concern** you have about the future that you want to avoid, or it could be a hope about the future that you want to encourage.
4. Share your ideas with your team.
5. Take out and examine your *Energy Source Cards*. In Part 1 you arranged these cards in the order in which you think they would be most helpful for your community. Create a new order based on what you have learned during this guide.
6. Discuss with your team:
    a. What, if anything, has changed about your card order?
    b. What do you want to remember as you are thinking about actions you want to take for a sustainable future?

7. As a team, come to **consensus** on one part of the future you want to take action on. A consensus is a balanced decision that works for everyone in the group. There are many ways to come to consensus. Here are some ideas. You can choose whatever works best for your team.
    a. List the good things and bad things about taking action for each future. Discuss as a team.
    b. Try to find the same values. Are there some ideas about the future that are similar? Try to combine them.
    c. Build a sense of the group opinion. Are there some ideas about the future that many people would be interested in working toward?
    d. Find a slow consensus. Find a partner and as a pair find consensus on which future idea is most important. Then in a group of two pairs (four team members) you can build consensus among the four of you. Then in a group of four pairs (eight team members) you can discuss further to build consensus. Keep adding groups together until you have found a team consensus.
    e. Consider your **impact**. Think about who would benefit from your team working toward a specific idea about the future. Which group are you most interested in helping?
8. Once you have chosen a future you want to work toward, you need to think of an action to take that might help create that future. Get out a piece of paper and write or draw any actions you can think of. If you are having trouble thinking of actions you can take, here are some ideas you may want to consider.
    a. Personal choices: Could you make energy conservation a part of your life, or a part of your household? Could you make choices in the way you move around your community that reduce the amount or change the kind of energy you use? Could you choose a career that helps increase the use or knowledge of low-carbon energy sources?
    b. Educate others: Other people you know may not know much about sustainable energy. Could you choose a group and help them learn more?
    c. Communicate with your community: Could you help your community understand sustainable energy or a concern you have by designing posters, composing songs, recording podcasts, making public service announcements, setting up a social media campaign, or using other ways to communicate?

d. Government change: What does your local or national government do now to encourage people to use sustainable energy? What are the laws, policies, or **incentives** that help people choose, use, or pay for low-carbon energy? Try to change the rules your local or national government has about sustainable energy. For example, you could write letters to officials or speak at local government meetings to share the actions you think are necessary to create the future you want.

e. Global change: Remember that access to energy is a problem around the world. You have investigated the people in your community who have a hard time getting reliable, safe, and affordable access to energy. Could you do the same research about places outside your community? Could you pair with a community somewhere else in the globe and exchange ideas about how to increase the use of sustainable energy?

f. Come up with your own ideas!

9. Read this quote from Dr. Hal Wallace, curator of the electricity collections at the National Museum of American History in the Smithsonian Institution. Hal's job is to do research that helps educate people about the past and future of energy and electricity. There are many types of useful actions to take. Hal is suggesting one kind. Do you think that action might be one you and your team wants to take?

At the Smithsonian

"How can you be an **advocate** in your community? Find out who is in charge of your local power and start attending those meetings. Ask questions. Push them to adopt sustainable sources of energy. Ask them to improve the electrical grid. Instead of being a passive member of the community, become an active one."

Understand: *What will my role be?*

Now it is time to plan your action. As you have learned, variations among people's **perspectives** and abilities can make the whole team stronger. Think about what role you will take to help with the team action.

1. Take out your *Identity Map* from Part 1 and examine it closely. Make a note of things about your **identity** that might help you decide how you would like to act. For example:
   a. Are you part of any groups that you could communicate with?
   b. Do you have any special talents, such as art or music, that might be useful to capture people's attention?
   c. Are you interested in science and engineering or other ways to try to find solutions?
   d. Do you have good planning or organizational skills?
   e. Are there other things about your identity that might help you work toward the future you want?
2. Gather with your team. Write "Team Strengths" on a sheet of paper or on the board.
3. Write down all the ideas each person had about things from their identity that might help you all act.

> **⚠ Emotional Safety Tip**
>
> Everyone has strengths and weaknesses. As a team member, sharing your unique strengths is important, even if it feels uncomfortable. It is important to respect your own strengths and to respect what others identify as their strengths.

4. Break into four groups and assign each group one perspective: **social**, **environmental**, **economic**, and **ethical**.
5. As a group, consider each potential action from the Discover activity from your assigned perspective.

a. Think about how this action might help from your assigned perspective.
b. Think about how this action might hurt from your assigned perspective.

6. As a team, discuss the different perspectives on the actions you thought of in the Discover activity. Remove any actions that would not be helpful or that you cannot do.
7. Share your ideas and listen to others. Come to a consensus about which action you will take, using your *Team Strengths* list to help you decide the best action for your team. You can use some of the consensus-building ideas from the Discover activity, if you want.
8. Discuss with your team any other actions you took while using this guide. Is there anything you learned that you need to remember when you are taking this action?
9. Think quietly to yourself about the steps that could be part of planning the action your team picked.
10. Write, draw, or use another way to record your ideas on small pieces of paper. Each piece of paper should have one step of the action you have chosen.
11. Have each team member share their steps by placing their pieces of paper on a table or by using a digital tool to **collaborate**.
12. Read through the steps from your teammates.
    a. Did you notice any steps that were similar to yours?
    b. Do you think your team is missing any steps?
13. Start to organize your team's steps. You can move the pieces of paper around as you do this. Thinking about your team's steps will help you decide how you will take action.
    a. Group any similar steps together.
    b. Remove any steps you don't think are needed to help your team take action.
    c. Think about how each team member will help. Put their names with the steps they would like to help with.
    d. Think about what steps might be missing. Add those steps.
14. Put the steps in order. For example, what do you think the team needs to do first? Place that piece of paper before all the others.

15. Title a sheet of paper "Action Plan" and record the following:
    a. The steps your team would like to take
    b. The order of those steps
    c. Who will help with each step (it might be more than one person)
    d. When and where you will take these steps
    e. Partners or other people you will involve
    f. How you will communicate your action plan to the community
16. Think about what you will do if your plan doesn't work, or you run into another problem. For example, what will you do if an adult in your community says you need permission to do something in your plan? Record these ideas as part of your action plan.
17. Remember to create an **inclusive** action plan. Being inclusive means everyone on your team can participate in some way. You may need to make changes to the plan so that everyone feels safe, comfortable, and able to help. Those changes are okay! They are part of being a good teammate.

Act: *How will I put my ideas into action?*

The time has come to act! You can use everything you have learned to take action to help create the future you want.

1. With your teammates, implement your *Action Plan*. This may take some time. There is no need to worry; take the time you need. When you are finished, come back and complete this activity.
2. Think quietly about the action you took. Consider:
    a. What went well?
    b. What do you think could have gone better?
    c. How would you change your action if you had to do it again?
3. Discuss with your team:
    a. What makes you proud of yourselves as a team?
    b. What do you think you have learned for next time?

4. Examine your *Futures Mood Board*. How are you feeling about the future now?
5. Think quietly to yourself about what you plan to do to create the changes you want to see in the future.

Congratulations!

You finished the *Energy!* Community Research Guide!

All of us should be trying to do what we can to change ourselves and our world for the better. Maybe you took a big action. Maybe you took a small action. Maybe it had a big impact. Maybe it had a small impact. The most important thing is that you did something. When you take action to make your community better, you create the world you want to live in. You and your team are changing the world, one step at a time!

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.

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Advocate: A person who recommends or supports a particular cause or idea

Collaborate: To work together on an activity or toward a goal

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

Concern: Something that causes anxiousness, worry, or fear

Consensus: A balanced decision that works for everyone in the group

Economic: About money, income, and the use of wealth

Energy: Anything that gives the ability to do work

Environmental: About the natural world

Ethical: Something that is fair

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

Identity: The characteristics that make you you

Impact: The effect one thing has on another

Incentive: Something that encourages people to participate

Inclusive: Making sure no one is left out

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

Social: Relating to the interaction of people in a community

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

Meet Logan Schmidt, Your Energy Guide Developer

Meet Logan Schmidt. Logan (*LOH-gan*) was the main person writing this guide. She talked with lots of researchers to get information. However, like anyone, she has her own perspective. You have learned it is important to consider the perspectives of your teammates and research mentors. Perspectives affect what we think and how we think. It is also important to think about the perspective of the writer. This can help you understand why the guide was written the way it was. Considering the source of information is always a good idea. To help you, Logan filled out an identity map, just like you did in Part 1.

Logan's Identity Map

Before you finish the guide, think quietly to yourself about Logan's identity map.

- What questions do you have about the way the guide was written?
- What perspectives does Logan have that might have made her write the guide the way it is?
- Are there things you would include that were not included?

Do you want to tell Logan what you would change about the guide? Email her at scienceeducation@si.edu. She'd love to hear from you!

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Parents, Caregivers, and Educators
Action Plans can be shared with us by using hashtag #SSfGG!

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Smithsonian Science for Global Goals (SSfGG) is a freely available curriculum developed by the Smithsonian Science Education Center in collaboration with the InterAcademy Partnership. It uses the United Nations Sustainable Development Goals (SDGs) as a framework to focus on sustainable actions that are student-defined and implemented.

Attempting to empower the next generation of decision-makers capable of making the right choices about the complex socio-scientific issues facing human society, SSfGG blends together previous practices in Inquiry-Based Science Education, Social Studies Education, Global Citizenship Education, Social Emotional Learning, and Education for Sustainable Development.

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