Solar Energy

Middle School NGSS Unit

STEM

A digital copy of this document is available on the STEM Materials Center website at: https://www.stemmaterials.org/solar-energy/

STEM
Science
Technology
Engineering
Math

A program of Educational Service District 112 supporting Next Generation Science Standards

Background on the Core Scientific Ideas in this Unit

How can solar energy be harnessed to help improve the quality of life and reduce the environmental impact of a community?

Is lack of electricity a global problem, especially in countries like Kenya?

How can we create a device that uses solar energy to perform a crucial function?

These are questions that will introduce students to the positive impact that solar energy can have in how we produce electricity, in our sustainability as a community, and in our quality of life. Students will develop their skills in Science and Engineering Practices and argumentation by taking a critical lens on energy production and use while looking at the energy mix of their local Public Utilities Company. Through a series of games and simulations, students will develop their understanding of renewable and nonrenewable resources and the impact that they have on the environment. After constructing their own definition of renewable and nonrenewable sources, students will explore the use of solar energy (a renewable resource) in generating power for people living off-the-grid. Students will create a working model to show the transfer of energy taking place when photovoltaic cells generate electricity. Through a series of investigations, students will build, refine, and optimize a solar-powered device and generate electricity; their design challenge will involve the creation of a device to improve the quality of life for people living off-the-grid in Kenya. Students will then communicate information from their investigation to their classmates and explain the process of constructing their device and how it can improve the quality of life for people who have limited access to electricity across the globe.

BACKGROUND (cont.)

WHAT WILL STUDENTS KNOW AT THE END OF THIS UNIT?

- A lack of electricity can negatively impact a person's quality of life.
- Humans use different energy sources to generate power, some which are renewable and some which are not.
- Renewable resources are constant and replenish themselves as they are used. Nonrenewable resources are depleted overtime and do not replenish themselves.
- Sustainable resources are those that are renewable and have limited impact on the environment.
- Oil, coal, and other fossil fuels are nonrenewable resources and will eventually be depleted. Nonrenewable resources also have negative impacts on the environment and human health.
- Wind, solar, and hydro power are renewable resources, as they cannot be depleted and they have minimal negative impact on the environment and on human health.
- A solar panel uses photovoltaic cells to generate an electric current and provide electricity.
- Photovoltaic cells may be connected in circuit to a battery which can store electrical energy for later use.
- Different variables can be manipulated to maximize energy output of a solar panel.

UNIT OVERVIEW

Lesson No.	Duration	Materials Needed	Focus	Assessment Options
1	4-5 days	Computers with internet access	**Engage** • Read about the electricity access problem around the globe. • Define why lack of electricity can be a problem. • Discuss the impact of different energy sources on the environment. • Analyze data to assess the sustainability of energy used by the local Public Utilities Company. • Conduct public surveys and collect data to assess public awareness and local energy resource potential. • Write a CER argument in the form of a "Yelp" review to rate local Public Utilities Company.	CER argument about sustainability of community's energy production.
2	5-6 days	Computers with internet access, long rope (jump rope), bell, LabQuests (or computers with ezlink), Vernier Energy Sensors, Vernier Variable Load, KidWind 2V solar panel, 2 wire leads with clips, Protractor, Light bulb, Light bulb socket or lamp, sunshine	**Explore** • Create a KLEWS chart about solar energy. • Research solar energy and create an initial model of a solar panel. • Explore materials and build a solar panel. • Refine model based on investigation.	Working model of solar panel.
3	3-4 days	Computers with internet access	**Explain** • Play a game/simulation to model the photoelectric effect. • Watch videos about photovoltaic cells and the photoelectric effect. • Revise previous model of solar panels to include new detailed information.	Revised model of solar panel.

UNIT OVERVIEW (cont.)

Lesson No.	Duration	Materials Needed	Focus	Assessment Options
4	4-5 days	Computers with internet access, long rope (jump rope), bell. LabQuests, Vernier Energy Sensors, Vernier Variable Load, KidWind 2V solar panel, 2 wire leads with clips, Protractor, Light bulb, Light bulb socket or lamp, sunshine, materials to test variables (will depend on experiment design), clear tape, ice bath, sunshine	**Expand** • Revisit driving question and create an investigation to identify how a certain variable affects power output. • Collect and analyze data to refine device. • Communicate findings to peers. • Improve or recreate model of solar panel using collective data.	Investigation write-up and presentation of scientific findings
5	8-9 days	LabQuests, Vernier Energy Sensors, Vernier Variable Load, KidWind 2V solar panel, 2 wire leads with clips, Protractor, Light bulb, Light bulb socket or lamp, sunshine, materials to test variables (will depend on experiment design), clear tape, ice bath, sunshine, Ring stand, different colored pieces of paper, ruler, lamp and 100W bulb (or LEDs), aluminum foil, various materials for building (cardboard, plastic bottle and boxes, containers, etc.)	**Evaluate** • Discuss and describe the problem they are trying to solve. • Design a solar powered device that produces greatest amount of power with the most efficient design while solving the problem. • Test the device to assess for functionality and needed adjustments. • Share proposal and device and describe how the solution will improve quality of life for Africans living off-the-grid.	Engineering Design process, final proposal and presentation.

LESSON 1: Africa's Electricity Access Problem

Strategy: Engage

Students *engage* with the storyline and set the context for learning (4-5 days).

Driving Question for this Unit: How can we use solar energy to improve the lives of people living "off-the-grid" in Kenya?

Introduce Global Electricity Access Problem: Students look at data from The World Data Bank and analyze the data presented. Students pick 2-3 countries (including the U.S. and Kenya) and analyze data from each country. They can then create an excel chart and graph to display their analysis. How does access to electricity differ across the world? https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2014&start=1990&view=chart

The World Bank: Access to electricity (% of population)

Technology connection:

Teachers with district-wide access to ProQuest may access Culture Grams as a resource to collect in-depth comparative information and data for different countries. This resource provides students with a snapshot of the social, historical, and geographical characteristics of a country.

- Information on a specific country can be found using this map: https://online.culturegrams.com/world/
- Comparative tables can be generated using this link: https://online.culturegrams.com/world/comparison.php

Students can create comparative tables for various energy-related criteria (electricity consumption, natural gas consumption, etc.)

Finding Patterns in data:

- **Is there a pattern?** Do you observe a pattern or a problem with the distribution of electricity access? Does everyone have equal access to electricity? Is there a disparity?
- **Why is this a problem?** How does access to electricity affect the quality of someone's life? What problems might arise in communities with limited access to electricity? How are the people in villages in Africa effected by these problems?

Materials Needed
Computers with access to the Internet

LESSON 1 (cont.)

Articles to engage students in this discussion:

http://www.independent.co.uk/voices/comment/imagine-life-without-electricity-thats-the-reality-for-two-thirds-of-africa-and-the-results-are-10300033.html

http://www.bbc.com/news/av/business-40221362/how-can-africa-s-electricity-problem-be-solved

Social Studies connection (optional extension):

Students engage in a social studies lesson in which they read about two children their age and compare/contrast the quality of life. https://tc2.ca/pdf/samplecriticalchallenges/Caring1.pdf After engaging in this lesson, students can come up with a definition for the term, "quality of life." Why does the problem exist? Students discuss access to resources and why this varies amongst countries. Why do we have more access to resources than people around other parts of the world, such as many countries in Africa?

Renewable and Nonrenewable Energy Sources:
Introductory games/simulations about energy sources:

- Renewable vs Nonrenewable Resources Popcorn game with PowerPoint: https://goo.gl/bgzbse
- Tragedy of Commons game: https://www.sciencefriday.com/educational-resources/one-for-all-a-natural-resources-game
- Brain Pop Sorting Game: https://www.brainpop.com/games/sortifynaturalresources/

Have students focus on the process of sorting and not the actual score.
How did they sort different resources? How did you determine whether something was renewable or nonrenewable?

- Save the World Game: https://wonderville.org/asset/save-the-world Actual game is best fit for 3-5, but informational segments about renewable resources in between game sessions may be helpful to students. Rising inquiry questions from sorting results may lend to interesting discussion amongst students.

After students have engaged in some games/simulations, facilitate a discussion about renewable and nonrenewable sources. **What is the difference between a renewable and a non-renewable source?** Provide students with the definition of renewable energy and ask students to work in teams to create a list of as many renewable and nonrenewable energy sources they can think of. Tell students that if there are any disagreements about whether a resource is renewable or nonrenewable, the team must discuss until they reach consensus. Ask teams to share out their results and share their thinking with the whole group. Spend some time to discuss the negative health and environmental impacts of using fossil fuels as an energy source.
Follow-up video: https://www.youtube.com/watch?v=pBTnVoEIb98&t=188s

Materials Needed

Computers with access to the Internet

Local Learning: Where does our energy come from?: Tell students that they will be investigating the sources of energy being used to generate electricity in their communities: What different energy sources does your local Public Utilities Company use to generate energy? Where does the majority of the energy come from? Present students with resources from your local Public Utilities Company, and ask students to analyze the various community resources that the company uses to generate electrical energy for its population. Is the energy coming mostly from a renewable or nonrenewable source? Are the region's resources being adequately used to support the needs of the community?

- Clark County Statistics (look in "Fast facts about Clark Public Utilities")
  https://cdn5.clarkpublicutilities.com/wp-content/uploads/2016/08/2015-Owner-Manual2.pdf
  https://www.clarkpublicutilities.com/about-cpu/public-documents/integrated-resource-plan/
- Skamania: https://www.skamaniapud.com/wp-content/uploads/JUNEJULY2015.pdf
- Klickitat: http://www.klickitatpud.com/news/kpudNews/fuelReport.aspx
- Pacific: http://www.pacificpud.org/pud/es_mix.html

Math connection:

"Grid and Percent It" lesson: https://illuminations.nctm.org/Lesson.aspx?id=960. This is a Mathematics lesson which helps students tackle the concept of percentages by using 100 square grids as a visual model to represent percents. Prompting questions: What is a percent? How can we use a grid to represent some of the data that the local PUD has provided about our local energy sources?

What's in your Energy Portfolio Project (optional extension):

http://energyforkeeps.org/wp-content/uploads/2011/08/ch5_activity.pdf

Once students have studied their local energy mix, they can engage in this lesson to further assess local energy resource potential, investigate future plans for renewables, and collect public awareness data using a survey.

Materials Needed

Computers with access to the Internet

LESSON 1 (cont.)

How sustainable are we? Yelp Review (formative assessment):

Ask students to become "Yelp" reviewers and to use data to make a claim and assign a "sustainability" rating to their Public Utility Company out of 5 stars (5= extremely sustainable community and 1=not so sustainable community).

They should use the ideas they discussed about sustainable and non-sustainable practices to write their reviews. **Why does their PUD earn that specific star rating? Are there factors that may constrain the PUD's ability to become completely renewable? What might those factors be?**

Remind students that the most credible reviews are backed up with multiple pieces of evidence. There may be disagreement between students' ratings which is encouraged. Teacher can facilitate a discussion where students justify their star ratings and read their reviews to the class. Their Yelp review should include a numerical rating (their star rating) and be supported with evidence and reasoning. Ask students to include a CER argument as a part of their Yelp review.

Materials Needed
Computers with access to the Internet

LESSON 2: What is Solar Energy?

Strategy: Engage

Students will explore the potential of solar energy to help broaden access to electricity for people in rural areas. (3 days)

Connect with the storyline: What is our driving question? How can solar energy help improve the lives of people who live off-the-grid in rural Kenya?

Have students read and respond to the following articles:

- http://www.cnn.com/2016/12/15/africa/off-the-grid-tanzania-rwanda/index.html
- http://www.worldbank.org/en/news/feature/2017/02/13/making-renewable-energy-more-accessible-in-sub-saharan-africa

Work with students to create a KLEWS chart (http://static.nsta.org/files/sc1506_66.pdf) on the topic of solar energy. Before they study how solar energy will be used to improve the lives of people who are living off-the-grid, ask students what they know about solar energy. What is solar energy? What do they know about it? How have they seen it being used by people (and other living things)? What wonderings do you have about solar energy? What skills or knowledge do you still need before you can try to help solve this global problem? Besides humans, are there other living organisms that use solar energy? If so, how do they use it? How is photosynthesis similar to solar panels? Have students create an individual KLEWS chart in their science notebooks and compile ideas in a whole-group chart. If using google classroom, you can have each student create an individual KLEWS chart as a live document to record evidence of their learning throughout the Unit. Link to google KLEWS template: https://goo.gl/mYQMy5

Videos to further engage:

- Introduction to Solar Energy video: https://www.youtube.com/watch?v=bhcIJRdyrQg
- Fun music video about the Sun, "Why Does the Sun Shine" by *They Might Be Giants*: https://www.youtube.com/watch?v=3JdWISF195Y

Materials Needed
Computers with access to the Internet

LESSON 2 (cont.)

Creating an initial model of a solar panel:
Provide students with the materials that they will be using to create a solar panel generator.

What is the importance of each part? How do they work together to generate electricity?
How does a solar panel create electrical energy using solar rays?
Ask students to create a model showing how energy is transferred and transformed in a solar panel. They can use arrows to show the transfer of energy from one object to another. If students are fairly comfortable with Google Suite (Google drawing), then encourage the use of this online platform to create the model. This way, students will be able to easily make modifications to their models as their thinking develops.

Renewable Energy with Vernier-Experiment 17: Exploring Solar Panels (3-4 days):
After students have explored materials, they can start building their solar panels and determine the efficiency of the solar panel. How is energy being transferred from one form to another here? What evidence do you have to show that energy was being transferred? Have students revisit the KLEWS chart and add/change. Students can also revise their initial model of a solar panel to include new ideas they uncovered during their investigation.

Materials Needed Vernier Experiment 17
LabQuests
Vernier Energy Sensor
Vernier Variable Load
KidWind 2V solar panel
2 wire leads with clips
Protractor
Light bulb
Light bulb socket or lamp
Sunshine

LESSON 3: The Photovoltaic Effect

Materials Needed
Computers with access to the Internet

Strategy: Explain

Students will *explain* how solar panels generate electricity using energy from the Sun (3-4 days).

Modeling Energy Transfer in Solar Panels Activity/simulation
http://www.greeneducationfoundation.org/institute/lesson-clearinghouse/download/file.html?fid=19.281
In this activity/game, students will act out the process of electron excitement that occurs when photons hit a photovoltaic cell. This process is called the photoelectric effect and can be included in students' revised models later in this lesson. This activity can be used to help students develop a concrete understanding of what is happening inside a photovoltaic cell. The activity can also be used to help expand understanding of DCI PS3.B: Conservation of Energy and Energy Transfer (https://www.nextgenscience.org/dci-arrangement/ms-ps3-energy), with a focus on how energy from the sun is being transferred to particles in a photovoltaic cell. Students can also use this phet simulation about the photoelectric effect to collect more observational data which helps them to explain the phenomenon of solar energy production.
https://phet.colorado.edu/en/simulation/photoelectric

Revising the model (formative assessment):
Ask students to work individually to revise their model of the solar power generator. Students can:

- Use arrows to show the transfer of energy in the solar panel.
- Use a "zoom-in" box to show what is happening in the solar panels to generate the electric current (electrons getting excited). Use captions to label what materials are used to build each part of the solar generator.

Then reflect and discuss with team: how would a solar device help solve the energy access problem in Africa?
Ask students to revisit their KLEWS chart and add their thoughts and ideas.

Other supplementary materials:
Article about how solar panels work: https://www.saveonenergy.com/how-solar-panels-work/
Video about how photovoltaic cells are made (what's inside them?): https://www.youtube.com/watch?v=BKrOZ6OogmQ
NASA Article about the history and physics behind photovoltaic cells: https://science.nasa.gov/science-news/science-at-nasa/2002/solarcells
Need.org: power point presentations about solar energy: http://www.need.org/solarmaterials

LESSON 4: Investigating Efficiency

Strategy: Expand

Students will expand their understanding by investigating how different variables affect the power output of their solar panel (4-5 days).

Connect to community:

Have students seen solar panels in communities in Southwest Washington? Based on the data from the local PUD, is solar energy being harnessed in their community? Do they have any wonderings about how climate conditions may affect solar power input and resulting output? What times of the day is solar energy production going to be at its maximum? What times of the day will people be using the most electricity? Do these intervals of peak production and peak use match up? How can we help a make better use of the energy being generated?

Career connections:

Ask students to think about the different careers and jobs that might be involved in this process of solar energy production for their community. Here are three relevant careers that can be discussed in depth. Reach out to the WA STEM network for the opportunity to connect with these professionals and have them possibly visit your classroom.

- An **Energy Services Project Manager** works for a local public utilities provider and on projects that improve the sustainability of the community while increasing energy conservation. What knowledge and skills might be necessary for an Energy Services Manager to do her job well?
- A **Solar Energy Engineer** plans, designs, and carries out different solar energy projects for different clients. They may be working with a large community or company to install a large-scale system for collecting solar, or they may work with smaller clients like individuals who own homes. What skills must a solar engineer have? (computer programming skills, mechanical and electric skills, communication skills, problem solving skills)
- A **Solar Technician** installs PV (photovoltaic) Systems on rooftops for a solar power company. A Solar Technician works on an installation team and prioritizes efficiency, safety and communication. What are some skills that a Solar Technician must need in order to do her job well?

Connect with the storyline:

How can we create a solar panel that is efficient for people in a rural village to use? How are environmental conditions in Washington different from those in Kenya? What are some of the variables that might differ because of the differing climates (ex. temperature, sunlight, humidity, etc.)? Ask students to think about how these varying conditions may benefit or hinder production of electricity. What variables do they think will improve production? What variables will create barriers in production? Students will work in their teams to study several variables that may affect the energy output of the solar panels.

Materials Needed

Vernier Experiment 19 & 20:

Computer

LabQuest (or Vernier data collection interface)

Vernier Energy Sensor

Vernier Variable Load

Light Sensor (optional)

KidWind 2V Solar Panel

2 wire leads with clips

Materials to test variables (will depend on experiment design)

Clear tape

Ice bath

Sunshine

LESSON 4 (cont.)

Renewable Energy with Vernier-Experiments 19 & 20: Variables Affecting Solar Panel Output & Effect of Temperature on Solar Panel Output:
Students will conduct an investigation to help develop their working model of a solar panel. Teams of students will pick one variable and create an investigation to refine their design and optimize power output. This will allow students to further expand towards mastery of DCI (Core Idea) ETS1.C (and PE MS-ETS1-4). Each team of will specialize in one variable (wavelength of light, air temperature, angle in relation to horizon, orientation, time of day, etc.) and will be asked to share their findings as a whole group. Google slides or sheets can be used to document and present data. A collective document can also house information gathered and analyzed by different groups to create easy access to info for use during the engineering challenge.

The following prompts can be used to scaffold the process:
- What is the real-world problem that you are trying to solve?
- What is the goal of the investigation?
- How will your solar panel help to solve that problem?
- What variable will your team be manipulating? Why did you chose this variable? What variables will you be controlling?
- How will you collect your data?
- How will you analyze your data?
- How will you use the data you collect to design the best solution to the problem?

Formative assessment: How will you work with your group to communicate your findings to the class in a way that will be useful to them (poster, graph, slides, or handout?).
In the next part of the lesson, students will be working in teams to create their final prototype design of the solar panel. What information would be useful to the rest of the class and how can they share it? After groups are ready to share their findings, have them present to the class. Then give some time after the presentations for teams to discuss all the data that was presented to them by their peers. What did they learn from other groups that was helpful? Was the information shared by other groups consistent with their findings? How can this collective data be used in the final engineering process? What design features will they adopt? Are there any findings that they wonder about? Encourage students to follow-up with other groups about questions they may have about the findings.

Have students revisit their individual working models of a solar panel generator and create adjustments to optimize the design. At this point, students may want to create a new model that incorporates everything they have learned so far. Remind students to revisit their KLEWS chart and made additions. This may serve as **a formative assessment** opportunity for teachers.

Materials Needed

Vernier Experiment 19 & 20:

Computer

LabQuest (or Vernier data collection interface)

Vernier Energy Sensor

Vernier Variable Load

Light Sensor (optional)

KidWind 2V Solar Panel

2 wire leads with clips

Materials to test variables (will depend on experiment design)

Clear tape

Ice bath

Sunshine

LESSON 5: Building the Solar Device

Strategy: Expand

Students and teacher can evaluate what they have learned throughout the Unit by applying their understanding of solar energy to build an efficient device that is able to generate electrical energy for a specific purpose (8-9 days)

Ask: What is the problem we are trying to solve? What type of device would you like to focus on to improve the quality of life for people (ex. A solar charger, a solar collector, solar cooker or other)? How will your device help solve this problem? How will your solar device help to improve the lives of people living "off-the-grid?" What is the purpose of technology? (answer: to improve the quality of life and make things easier for people to do)

Examples of solar powered technology:

- Students can learn about a very simple solar-powered invention which is a part of the "Liter of Light" Foundation and has helped improve the quality of life by bringing light into the homes of families all over Asia: https://www.youtube.com/watch?v=cQCHvO2H0_0
- Bringing electricity to school in Malawi, https://www.youtube.com/watch?v=kCafRaHYacg

The following Vernier Experiment guides may be used to scaffold each team's specific problem-solving ideas/direction:
Renewable Energy with Vernier-Experiment 21: Build a Solar Charger
Renewable Energy with Vernier-Experiment 24: Exploring Solar Collectors
Renewable Energy with Vernier-Experiment 26: Solar Cooker

Design: Students will then work in their teams to design a solar device. What type of device would they like to create? What are some of the important structural features of the device that will make it functional to people? What materials will they use? How can teams apply the data they found about building a device that is effective and generates the most amount of power?
How will the circuits of the device be wired? What will the case of the device look like? Will you have to add components that improve its performance and functionality (ex. Is enough light getting to the solar panels?

Check: Students will test their device to test for efficiency. Is the device working properly? Are results replicable? Is your device easy to use? Does it perform the function you intended? Will it improve the quality of life for people who are off-the-grid in Africa? Are there any barriers or constraints you are experiencing? How can these constraints be addressed?

Materials Needed

Vernier Experiment 19 & 20:

Computer

LabQuest (or Vernier data collection interface)

Vernier Energy Sensor

Vernier Variable Load

Light Sensor (optional)

KidWind 2V Solar Panel

2 wire leads with clips

Materials to test variables (will depend on experiment design)

Clear tape

Ice bath

Sunshine

LESSON 5: (cont.)

Share: How will you present your proposed solution to a larger audience? What was the problem you were trying to solve and how does your device help to solve that problem? How does your device supply power to people living off-the-grid? Also ask students to think about people living in their community: how can some changes be made in the community to help create a more sustainable framework for energy production. Students can create a presentation to accompany their device and explains the problem they addressed, and how their device helps to solve that problem by giving people access to electricity. Students can also focus on the local connections

Summative assessment: Students' projects/presentations can serve as a summative assessment. Students engaged in the SEPs of asking questions, constructing explanations and designing solutions, and communicating information while addressing the CCC of Energy and Systems. Students can create their presentations on google slides and embed videos of the testing/designing process.

Materials Needed

Vernier Experiment 21, 24, & 25:

Computer

LabQuest (or Vernier data collection interface)

Vernier Energy Sensor

Vernier Variable Load

Light Sensor (optional)

KidWind 2V Solar Panel

2 wire leads with clips

Materials to test variables (will depend on experiment design)

Clear tape

Ring stand

Different colored pieces of paper

Ruler

Lamp and 100W bulb (or LEDs)

Aluminum foil

Various materials for building (cardboard, plastic bottle and boxes, containers, etc.)

How This Unit Supports Next Generation Science Standards

MS-ETS1 Engineering Design

The materials/lessons/activities outlined in this activity are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required. NGSS connections are derived from the Evidence Statements for the Performance Expectations listed below.

Peformance Expectation	Connections to Classroom Activity
MS-ETS1-1: Define the Criteria and Constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2: Evaluate competing design solutions using a systematic process. MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify best characteristics that can be combined into a new solution. MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	• Students identify the problem of limited electricity access in rural areas which are off-the-grid in countries like Kenya. • Students identify the constraints and lack of resources that are contributing to a diminished quality of life in off-the-grid areas. • Discuss the difference between renewables and nonrenewable resources in solving the electricity access problem and identify which source will provide a better solution in terms of sustainability. • Discuss the relationship between solar energy and the design solution that is needed by off-the-grid communities. • Develop an investigation that helps to generate data and guides the design process so that an optimal design can be created. • Analyze data presented by peers to help understand, inform, and improve product design to fulfil the need of the clients.

How This Unit Supports Next Generation Science Standards (cont.)

SCIENCE & ENGINEERING PRACTICES	
Asking Questions and defining Problems Developing and Using Models Analyzing and interpreting data Engaging in argument from evidence Using Mathematics Communicating Information Constructing Explanations and designing solutions Conducting Investigations	• Students define the personal and global problem caused by lack of electricity access for people living in rural areas in numerous developing countries. • Students analyze and interpret local data to determine whether energy resources in the community are being used to their full potential to provide services for the community and reduce environmental impact. • Students use data analysis to create an argument based on evidence of the sustainability of their community. • Students create a working model of a solar panel which is revised to accommodate their developing understanding. • Students construct and conduct an investigation to test how a specific variable affects solar energy production. • Students communicate their findings with their classmates. • Students use information from their investigations to optimize their solar panel device. • Students create a presentation to explain the engineering design process and propose their solution to the problem being faced by people living off-the-grid.

How This Unit Supports Next Generation Science Standards (cont.)

DISCIPLINARY CORE IDEAS	
Defining and Delimiting Engineering Problems Developing Possible Solutions Optimizing the Design Solution	• The problem being faced by Africa is influenced by the fact that most of their energy comes from nonrenewable resources and consequently has limited potential to serve people living off-the-grid. • Understanding the benefits of using renewable energy will allow for the creation of devices which will help create sustainable solutions for communities. • Using systematic processes and collecting data can help to identify optimum design features which can help to improve a device. • Repeating an investigation to collect and refine data can help to optimize design solutions. • Models can help in the development, testing, and optimizing of a design solution.
CROSSCUTTING CONCEPTS	
Influence of Science, engineering, and technology on society and the natural world Energy Cause and Effect Structure and function	• Students study how the use of certain types of resources, such as fossil fuels, can cause increased environmental impact, and decreased ability for a community (or nation) to be resilient in the aftermath of a natural disaster. • Different sources of energy have different impacts on the environment. Sustainable resources are those that are renewable and can be easily accessed by a community for long-term use. • Energy can be transferred from one form to another—there are many energy sources that are used to generate electricity. • Different variables can affect the efficiency of a solar panel.