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“Imagination is everything. It is the preview of life’s coming attractions”

— Albert Einstein
German born American physicist
(1879-1955)
Introduction and Overview

“To create the technology we use requires innovation. To innovate means to solve problems in fresh ways, often by asking new questions.”
— from Smart Energy Technologies and the Environment activity book

The lessons and activities in Smart Energy Technologies and the Environment provide an opportunity for students to build connections that link science with technology.

Students focus in introductory activities on all the ways their lives are powered by energy and the technologies that bring electricity to them. They follow an illustrated path through a power plant to see how electricity is generated and further how it travels to the end users. Along this journey students discover the many technologies that make the electric grid possible. Technologies, they learn are not only the machines, devices, and tools, but also processes (or methods) based on science that are used. As they progress through this study they also discover that our present electric grid needs to be updated and smarter. They will also learn that a smart grid is evolving.

Students work in groups to study both renewable and nonrenewable energy sources. They make connections between their daily use of energy and its production from fossil fuels, which generate greenhouse gases that contribute to global climate change. As they delve into their research students are able to identify both the advantages and disadvantages of every energy source.

Smart and Smarter

Students read informational text and complete activities that relate to the smart technologies in their own lives. The “smart” phones that many students carry are certainly not just for talking. These smart devices wake us up, take photos, play music, let us bank, or even enjoy a game or face to face chat with someone living on another continent. Activities in this study help students focus on the technologies that make these devices smarter. They will, for example, make a connection with smart energy meters that use digital technology much like our cell phones. Students will learn about some of the technologies being applied to the evolving smart grid.
Power of the Imagination

Students will discover in these lessons not only the energy sources that power all our technologies but the power that can come from our imaginations. As they collaborate to solve problems they will be testing the creative power of their own imaginations. In another activity they discuss green careers and jobs in the context of what they have studied in this unit. This unit is enriched with class projects on greening the school and a range of energy-related websites for students to explore. Throughout this study students will become aware of the choices they make about using energy wisely and the importance of protecting the environment.

Connecting to the Content Standards.

Lessons in this teachers guide have been correlated for grade six to Common Core State Standards (CCSS)* and the Next Generation Science Standards (NGSS).**

The three lessons in this guide along with the accompanying 38-page activity book, an Energenius Career Supplement, and suggested extension activities, provide many exciting and challenging learning opportunities for students.

*California Common Core State Standards for English-Language Arts & Literacy in History/Social Studies, Science and Technical Subjects (Adopted by the California State Board of Education August, 2010 and modified March, 2013)

**Next Generation Science Standards (NGSS) for California Public Schools, Kindergarten–Grade Twelve (adopted by California State Board of Education, September, 2013),
A World of Abbreviations

Teachers decipher and use many abbreviations in their daily work life. Abbreviations of late include CCSS for Common Core State Standards, NGSS for Next Generation Science Standards, and the acronym STEM. STEM has become an abbreviated way for educators, journalists, politicians, and parents to discuss and emphasize the teaching of science, technology, engineering, and mathematics.

The Utility World

In the energy utilities world there are also many abbreviations and right up front is DSM (Demand Side Management). DSM is something that affects more than utility workers in the energy sector because it involves anyone who is a consumer of energy. DSM covers actions that influence the amount of energy used and the time of day it is used. DSM also covers households and businesses that are generating their own electricity and often have a surplus to return to the electric grid.

DSM is an overarching idea that is made up of three main parts. These parts are energy efficiency (EE), demand response (DR), and distributed generation (DG). The California Public Utilities Commission (CPUC) refers to these three parts as Integrated Demand Side Management (IDSM).*

Demand Side Management (DSM)

DSM gives the consumer programs designed to both change the level and patterns of energy they demand. Utilities (the supply side) now offer incentives, real-time data, and messages related to shifting time of use, along with familiar energy efficiency tips.

Demand side management (DSM) programs have energy efficiency (EE) as a primary goal. Energy efficiency (EE) is also a major component in all of the PG&E Energenius materials beginning with the preschool child up through the middle school student. Students using the Energenius materials, are also introduced, as age appropriate, to demand response (DR) and distributed generation (DG).

* A California Public Utilities Commission IDSM Program Summary Fact Sheet can be downloaded at www.cpuc.ca.gov.
Smart Energy Technologies and the Environment

Within this teacher guide there are **EE**, **DR**, and **DG** icons that denote opportunities to introduce and/or review these topics for your students.
Lesson at a Glance

An introductory activity, What’s Powering Your Day, focuses students on how they are consuming energy each day. A reading about innovation and two inventors Thomas Edison and Alexander Graham Bell helps begin the discussion in this unit on how technology is used to meet an objective or solve a problem. Diagrams and readings next focus students on how electricity is generated and travels to where it is needed to power their homes and schools. The lesson concludes with a research activity on renewable and nonrenewable energy sources.

Teacher Background

Technology and its plural technologies are terms that are often misused and misunderstood. If asked for definitions your students might likely respond computers, cell phones, the internet, or solar panels. This lesson begins with some definition searching to define these words in the broadest sense. Yes computers are a technology and so were the first digging sticks and shovels.

Students as users of energy learn that they too are consumers in all four economic sectors (residential, commercial, industrial, and transportation) of the U.S. economy. Just as the federal government analyzes energy consumption by sectors, students will analyze how directly or indirectly they are consuming energy in the same sectors. They will realize when it comes to using energy they are not “just kids.” This lesson also provides students an introduction or reintroduction to how electricity is generated in power plants and the long journey it takes to reach their homes and schools. Information in lesson one on the existing power grid will help students understand the need for a smarter grid.

Student Objectives

- Students will be able to summarize informational text on energy consumption by sectors in the economy.
- Students will be able to define technology in its broadest terms and use it correctly in written and oral language activities.
- Students will be able to describe the pros and cons of the renewable and nonrenewable energy sources they studied.
- Students will be able to define innovation and provide examples of what is innovative about various devices.
- Students will be able to analyze diagrams and summarize text on how electricity is generated and travels from power plants to where it is used.

Materials

Provided:
- Smart Energy Technologies and the Environment student activity book, pages 1–13

Needed:
- Internet access

Time Needed

Two to three class periods
Pros and Cons

Students will learn about and/or review the various energy sources and be able to classify them as renewable or nonrenewable. Students, working in small groups, will select one energy source to research and present their reports to the entire class. As part of this activity students will present both the advantages and disadvantages of the energy source they researched.

The class will discover how some energy sources are available all the time, others under only certain conditions, how some do not pollute, and how others increase the amount of greenhouse gas (GHG) emissions in the atmosphere. In Lesson Two students will also learn how smart grid technologies will facilitate and make it easier to use renewable energy sources.

Vocabulary

climate change
Refers to any significant change in measures of climate (such as temperature, precipitation, wind) lasting for an extended period of time (decades or more). [www.epa.gov/climatechange/basic.info](http://www.epa.gov/climatechange/basic.info)

greenhouse effect
The effect produced when greenhouse gases trap solar radiation in the Earth’s atmosphere and warm the planet. This process occurs naturally and has kept the Earth’s temperature about 60 degrees Fahrenheit warmer than it would be without it. Current life on Earth could not continue without the greenhouse effect. [www.energystar.gov/index.cfm?c=kids.kids_index](http://www.energystar.gov/index.cfm?c=kids.kids_index)

greenhouse gas (GHG)
A gas, such as carbon dioxide (CO$_2$) or methane (CH$_4$), that traps the heat of the sun in the Earth’s atmosphere.

energy efficiency
The use of energy without waste. Energy efficiency refers to work done using the smallest amount of energy needed.

fossil fuels
Fuels formed from the remains of plants and animals that lived over 70 million years ago. Coal, oil, and natural gas are fossil fuels.

generator
A device used to convert mechanical energy to electrical energy.

global warming
Global warming is an average increase in the temperature of the atmosphere near the Earth’s surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, “global warming” often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities. [www.epa.gov/climatechange/basic.info](http://www.epa.gov/climatechange/basic.info)

innovation
A new idea, device, or method. The introduction of something new.

nonrenewable energy
A resource such as coal or oil that cannot easily be replenished. They were formed over millions of years ago.

petroleum (oil)
A natural, thick, flammable liquid made of the remains of plants and animals that lived over 70 million years ago.

pollution
Impurities in air, water, and land that create an unclean environment.

power plant
A place where energy is generated.
**Vocabulary**

<table>
<thead>
<tr>
<th>renewable energy</th>
<th>technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>An energy source such as solar or wind that can be restored by nature after it is used.</td>
<td>The application of scientific or engineering knowledge to a certain area. “High technology” refers to advanced scientific methods and materials, especially those involving computers and electronic devices.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new idea, device, or method. The introduction of something new.</td>
</tr>
</tbody>
</table>

**Procedures**

1. Place on the table a few items such as a flip top soda can, a cell phone, a zipper, hair dryer, etc. (Note: the items are all technologies that are useful things that solve problems.) Ask students if they know what all these items have in common. They might be surprised to know that they are all technologies and they all solved a problem. Discuss how the flip top meant drinks would not need an opener, the zipper replaced buttons and made a difference in clothing. Ask students how the present day cell phone is useful and what are the problems it solves. Continue the discussion and have students work in small groups to look up definitions of technology. Each group should also prepare five or six sentences that demonstrate an understanding of the term.

2. Distribute to each student a copy of the activity book and explain that the class will be studying about the energy that powers their lives and about smart energy technologies. Students should be asked to first read page 1, which poses the questions of “why” study about smart energy technologies and the environment. Ask students if they have any other answers to the why question posed on the opening page of the book. This question will be revisited at the end of this unit of study.

3. Have students read the information text, What’s Powering Your Day, on page 2. Discuss how total energy consumption (use) in the U.S. can be analyzed by sectors or parts of the economy. Ask students how, for example, they are directly or indirectly consuming energy in one of the four sectors of the economy. The text focuses students on the idea that when it comes to using energy there are more than “just a kid!” Review the directions on page 3 and have students complete the chart How I Use Energy by listing under each sector how they are consuming energy within that sector. Students should be prepared to share their lists with the class and also to summarize key points from the informational text on page 2.
Refer students to the Power Point box which covers information on greenhouse gas (GHG) emissions that contribute to global climate changes. Students should be encouraged to visit the listed Environmental Protection Agency (EPA) website (www.epa.gov/climatechange/kids/index.html).

Assign students to read page 4 and jot down what they consider key ideas in the text. Ask students to list questions they might have after reading this text on Finding Answers in Technology. Have students report on their questions and schedule time for these to be answered before starting the You Can Innovate activity. Students might need further clarification on the terms innovate or innovation.

Discuss the activity on page 5, You Can Innovate. Review the example of the shower and stress how smart technology can be applied to devices related to showering. Students should follow this example as they analyze the five items on page 5. This can be completed either by individual students or by small groups.

Introduce the reading, Technologies Bring Us Electricity, on page 6 and the two following pages of photos that illustrate the many steps in generating electricity and the “long journey” to get it where it is needed. Focus students on the path from the time a source is mined/dug to the stage where electricity lights a classroom or powers a computer. Petroleum (oil) is used as the example of an energy source, but students should realize that there are many energy sources (renewable and nonrenewable) that are used to generate electricity.

Ask students to read the information on William Stanley Jr. and discuss the invention of the transformer. This technology is used to bring the voltage of electrical energy up or down as needed. Organize students in groups to research the invention of the transformer or to complete the other two projects listed on page 6.

Assign students to read Travel the Grid on page 9 and list some key ideas from this text. Students should know that the “grid” or electric grid is not only the 300,000 miles of transmission lines, but substations, transformers, and all the technologies that bring electricity to where it is used. They should understand what voltage is and how it is reduced as it travels from power plants to large substations and onto smaller power lines. There are suggested projects on page 9 including conducting a simple experiment with a battery to demonstrate how electricity flows in a complete circuit. The following websites can be helpful in finding simple experiments related to electricity: www.energyquest.ca.gov, www.exploratorium.edu/snacks
9 Introduce the idea of renewable and nonrenewable energy sources by having students discuss the two words. For example, there are library books that can be renewed and other books so much in demand that they are nonrenewable. Explain to students that the informational text on page 10 and the activity that follows will help them understand why energy sources are classified as either renewable or nonrenewable. Nonrenewable sources like oil, coal, and natural gas once used cannot be easily regenerated. Renewable sources like solar and wind, once used can be replenished or made again by nature.

10 Review the text on fossil fuels (paragraph 2) and discuss the environmental impacts when these fuels are burned in power plants to produce electricity. The text in the Power Point! box discusses pollution and the greenhouse gas (GHG) emissions that contribute to global climate change. More information for students on GHG emissions and global climate change can be found at www.epa.gov/climatechange/kids.

11 Discuss the research project on the energy sources and organize students into small groups to each research and present a source to the class. Review the directions on page 10 stressing that students will need to cite three or more sources of information and present their findings in a “visual” and interesting way. Each group should also be prepared to discuss the pros and cons of each energy source. To promote “active listening” during report-back activities students should prepare questions to ask the class at the end of their presentations.

12 Students should write the pros and cons of the various energy sources in their own activity books. Teachers might want to do one large pros and cons classroom chart and have students copy the information into their own books. Review this activity by first asking students if their research has helped them discover the “absolutely perfect” energy source. Ask students why or why not?

13 Assign students the Make a Match activity on page 13. As students connect the correct phrases with the correct word or words they will be reviewing the content from Section I of the activity book. Answers to the Make a Match activity can be found in Appendix A.
Summarize the lesson by having students pair and share five or more key ideas they have taken from this opening lesson. These ideas should be discussed by the whole class and written on chart paper or a white board. At the end of this study these ideas could be revisited as part of a culminating activity.

### Extending the Learning

#### More than a Mouse
Research more about Douglas Engelbart, (1925 -2013), an American inventor and father of the mouse. Engelbart said in 1977 that in 20 or 30 years people will be able to hold in their hands as much computer knowledge that now exists in the whole world. Prepare a report for the class on the numerous contributions of Douglas Engelbart. Can you find any other predictions that he made?

#### Renewables Energy Sources and Distributed Generation
Research how homes, businesses, and even some schools are generating their own electricity using renewable energy sources like solar and wind. Include in this research examples from the area of California where you live and go to school.

#### Earth and Its Atmosphere Experiment
With your guidance students can conduct this experiment that illustrates the greenhouse effect. Ask students to imagine a giant greenhouse made up of the Earth and its atmosphere. Like the glass windows of a greenhouse, the atmosphere lets in the sunshine to heat the earth.

Explain that the heat that radiates from the Earth is trapped by the atmosphere. This is called the greenhouse effect. The gases that trap heat in the atmosphere are called greenhouse gases. Carbon dioxide (CO$_2$), methane (CH$_4$) and nitrous oxide (NO$_2$) are greenhouse gases.

**Materials Needed for Experiment:**
- Two glass jars of the same size
- Four cups of cold water
- 10 ice cubes
- Two thermometers
- One clear, sealable plastic bag
Directions for the Experiment:
1. Pour two cups (16 ounces) of cold water into each jar. (Use the ice cubes to chill the water.)
2. Place one jar into the plastic bag.
3. Place both jars in the sun for one hour or more.
4. Measure and record the temperatures in both jars. (Use a different thermometer for each jar.)
5. Record your findings.

Students should be able to describe (after conducting the Earth and Its Atmosphere Experiment) how this experiment helps explain the greenhouse effect.

"Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks."
— Middle School Standard (RST.6-8.3)

From: California Common Core Standards English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects (adopted by the California State Board of Education August, 2010 and modified March, 2013).
Lesson at a Glance

A historical look back to the 20th century sets the stage for students to examine all the things made possible by the “electrification” of the United States. Through readings and group activities they delve into the smart technologies in their own lives and move on to learn about the evolving smart grid with its enabling technologies.

Teacher Background

In the U.S. the demand for electricity is constantly growing in response to our needs and wants. In this lesson students learn that our country has an “aging” electric grid that greatly needs to be updated to meet these demands. The building of a “smart grid” is underway! Students will be introduced to some of the new technologies and equipment that will help meet the energy demands and challenges of the 21st century. An introductory activity focuses students on how “electrification” in the 20th century was considered one of the greatest engineering achievements of that time period. A reading on the largest North American blackout during the summer of 2003 will help them understand the need for a more modern (smart) grid. Fifty million people in North America were affected by the massive blackout.

Students will read and complete activities related to the evolving smart grid and as a bonus task to research newspaper articles written in August 2003 at the time of the massive blackout. A reading, Evolving: A Smart Grid, will help students understand
that it will take new technologies to be perfected, new equipment installed, and a
great deal of testing as this updated “smart” grid evolves. Students learn how smart
meters are providing smarter measures for consumers. As they complete an activity
on smart devices in their own lives, they will analyze how this device worked before it
was a “smart” device.

Vocabulary

advanced metering
Electricity meters that use two way communication between a utility and its customers.

blackouts
A loss of power affecting many electricity customers over an extended period of time and
spread across a large area.

demand response
Programs and ways that energy companies (utilities) and consumers can better manage when and how they use energy. Using less energy during peak demand hours is an example of demand response.

distributed energy generation
(Also called distributed generation (DG). The generation of electricity near to the place where it is being used. On-site distributed generation examples include a school powered by solar panels, a farm powered by its wind turbines, an office building powered by fuel cells.

electric grid
All the networks that carry electricity from power plants to where it is used. The grid includes power lines, substations, transformers, distribution wires and more.

electrification
A term to describe how electricity gets from a power plant to energy consumers.

megawatt
A unit of measurement of electrical power equal to one million watts or 1000 kilowatts.

outage
A period of time when a power supply is not available.

sensors
A device that detects or measures something and then responds to it. A motion–sensor
detects when someone enters or leaves a room and responds by turning lights on or off.

smart grid
A modernized electric grid. Will include technologies for two-way interaction between consumers and utility companies. Also allow for distributed generation and an increased use of renewable energy sources.

smart meter
An automated two-way communications system between a utility and its customers. Smart meters can measure and record the electricity used by a customer in “real time.”
Procedures

1. Ask students to open their activity books to page 14 and have them first read the text in the Power Point box. Have students define the term electrification, write and share a few sentences that correctly include this term. Have student pair and share at least five things that were made possible by the electrification of the U.S. Discuss the importance of the National Academy of Engineering (NAE) developing a list of what they consider the 20 great engineering achievements of the 20th century. This list can be found at www.nae.edu/engineeringachievements.

2. Have students read and summarize main points from the informational text on page 14. Their summaries should include but not limited to the following:
   - The power grid is a system (power plants, transmission lines, distribution stations, transformers, etc.) that deliver electricity to where it is needed. Students might add data from the Miles and Miles paragraph.
   - The grid hasn’t changed very much in the last century,
   - There is an increased demand for electricity and the aging grid needs to be updated (e.g., population of the US has grown from the time of Edison).

3. Organize the students into small groups to complete the four activities on page 15. They should begin by looking at the NAE list of 20th century achievement and tally and report how many of these engineering “achievements” they use most days. Each group should complete the chart on page 15, which focuses on some achievements that have already happened since the year 2000 and others they predict could happen in the 21st century.

4. Have students list five things that would happen if there was an outage at their home tonight. Students who have experienced outages first hand might be asked to share how it impacted them and their families. Ask students to turn to page 16 and provide them an overview of the blackout of 2003 when some 50 million people in eight states and Ontario, Canada were affected. For some that blackout lasted several days.

   Have students discuss in small groups how this event in the summer of 2003 relates to our study of smart energy technology. Ask students to follow along on page 17 while you describe the four Review, Recall, and Connect activities. There are also three bonus activities suggested for students that includes watching a PBS NOVA program on the smart grid.
Introduce students to the reading on page 18 by discussing the title (Evolving: A Smart Grid) and the Power Point box on this page. Students as they read and do the adjoining activities on page 19 should know what is meant by the word evolving. Discuss how the telephone has evolved over a long period of time into a smart and complex mobile device. Ask students what changes in cell phones they have seen in their own lives.

Introduce any vocabulary on page 18 that students might not understand before they read and write a summary of this informational text (e.g., sensors, distributed generation (DG), greenhouse gas emissions, two-way communication).

Summarize by having students provide the key points they recall from this reading.

Review the technology tasks on page 19 and organize the class in small groups or in pairs to complete one or more of the tasks on this page. Provide time for students to make presentations to the class on the work they have completed. Arrange for the identified smart grid YouTube videos to be shown during class time.

Introduce the reading on page 20 by first having students look at the Power Point! box and read the informational text about smart meters. Discuss what is meant by “real time” in the context of this reading and also how smart meters are “enabling devices” for the evolving smart grids. Have a few students read aloud the opening paragraph on page 20 that focuses on the idea that smart technology is everywhere.

Students should read the following three paragraphs and for each paragraph write two questions that they could be called on to ask the rest of the class. Some students might need to do some additional reading or research for this activity (e.g., the difference between digital and analog).

Examples of questions could include:

- What is wireless technology? (Give examples.)
- How would you explain Technology + Wireless x Energy Use = A Smart Equation?  
- What is an analog meter? How is it different from a digital smart meter?
• How can a smart meter help shift energy use from peak demand time?
• What were the major ideas in the Going Global paragraph on page 20.

Review for students the activity, How Smart is Your World? on page 21. Provide them several examples of smart devices, machines, applications, etc that can be considered smart. Ask students to consider what makes an elevator a smart machine. (Note: students might never have experienced an elevator with an operator inside opening and closing the doors.)

Have students work alone or with a partner to complete the chart on page 21. If assigned for homework students might discuss with family members how things changed when a certain device became “smart.” Students should share their ideas with the rest of the class.

Extending the Learning

✦ A Tech Word Wall
Create an illustrated word wall that features words /ideas students encounter in this study related to innovation and technologies. Encourage students to keep this word wall growing each week. Students might want to add quotes about technology and definitions for abbreviations like IOT (Internet of Things).

✦ School Energy Monitors
Students can volunteer as monitors for a school wide energy patrol. Patrol members monitor where energy is being wasted in the classroom and throughout the school buildings. The monitoring includes lights left on in empty rooms, computers not set in energy-saving mode, leaking water, windows open when air conditioners or heaters are working, lack of recycling, as well as paper that is being wasted. Monitors also identify good energy-saving actions taking place in the school. Information on forming an energy patrol can be searched at www.energyquest.ca.gov

✦ Get on Board — Take a Virtual Field Trip
The U.S. Energy Information Administration has a Kids page where virtual field trips can be discovered. Have students select one or more of these trips to experience. They can trek “virtually” to visit wind turbines off Cape Cod, a hydropower plant, a coal plant, an offshore drilling rig, a waste-to-energy plant a solar rooftop and many more sites. See www.eia.gov/KIDS/energy.cfm?page=field_trips
Renewable Energy and the Smart Grid
Suggest as a special project interested students could research why smart grid technology will make it easier to use more renewable energy sources. Some websites to begin this research are: www.smartgrid.gov and the Environmental Defense Fund site at www.edf.org/energy/smart-grid
Lesson at a Glance

Students discuss the power of ideas and complete an activity on the “power of the imagination” to culminate a unit where students have focused on inventors, innovations, and new technologies. An exploration of green careers follows as students learn about energy industry jobs and what makes them “green.” A crossword puzzle reviews some key ideas and vocabulary from this study. Lesson three concludes with students selecting activities and environmental projects to green the school, save energy, and conserve natural resources.

Teacher Background

The final lesson provides enrichment activities and suggests “Greening the School” environmental projects for the class to implement. Two scientists, a futurist, and a writer are used as examples of men and women who became famous for the power of their ideas. They all used their imagination to solve a problem and meet a challenge in science or other fields. Students will select and research inventors and innovators and also test the power of their own imagination by defining a solution to a problem they identify.

Measuring and Calculating

Students are also introduced to the language of energy measurement and calculate the amount of kilowatt hours (kWh) and costs for powering an appliance or piece of electronic equipment. The reading and activities on green careers and jobs offers opportunities for students to interview people working in renewable energy fields or those involved in developing some “enabling technologies” for the smart grid. As an
extension activity students are encouraged to create a career profile for a “smart grid” job that exists or will in the future.

A crossword puzzle covers 34 words or concepts presented in this unit. This activity can be used as a closed or open book activity.

At the end of this unit students should take home their activity books to share with parents or guardians.

Vocabulary

**goods**
Something used or consumed. The foods we eat and the clothes we wear are goods.

**green**
A color. Green can also be used to mean a person or process that helps protect or is “friendly” to the environment.

**green jobs**
Careers or jobs that focus on protecting the environment and conserving natural resources.

**kilowatt**
A unit of measurement of electric power that equals 1,000 watts.

**kilowatt-hour (kWh)**
A unit of measurement of electricity used which translates to one kilowatt used for one hour.

**peak demand**
The times during the day when the demand for electricity is the highest. This period of the day is between noon and 7:00 p.m.

**services**
A thing done for you by someone else, like a swimming lesson, a haircut, or a medical exam.

**therm**
A measurement of the amount of natural gas that is used.

**utility**
An agency or company that supplies electricity, natural gas, water or phone service.

A Working Definition of Green Jobs

Any activity or services that perform at least one of the following:

**Generation** and storing of renewable energy.

**Recycling** existing materials.

**Energy Efficient** products, manufacturing, distribution, construction, installation and maintenance.

**Education, compliance, and awareness**

**Natural and sustainable product manufacturing.**

Source: California Employment Development Department, [www.edd.ca.gov](http://www.edd.ca.gov)
**Procedures**

1. Introduce the **Power of Imagination** by asking students to first read the two paragraphs on page 22 and be prepared to:
   - Discuss what is meant by this “other” kind of power.
   - Describe how “inventions” often begins. (Relate to last sentence in paragraph 1.)
   - Summarize the text (Power of Ideas) in paragraph 2.

   Organize students in small groups to discuss the four people listed on page 22–23. Students should be able to tell briefly why they are famous and what did they “launch” for further explorations.

2. Introduce page 23 by asking students to discuss how the invention of the telephone addressed a problem people had. What was that problem? Students should realize that before the telephone was invented, people had to be in the same room to have a conversation. They couldn’t communicate over any distance.

   Each student should go through the process of defining a problem and the other two steps outlined in the directions on page 23. This could be an activity students complete for homework. Have students volunteer to share their solutions.

3. Have students work again in their small groups to do their own research on four inventors they select. For each inventor they should complete a template using the one on page 23 or another they create. Students should focus on how the people they chose used their imagination to solve a problem or meet a challenge in science or other endeavors.

   **Optional:** See pages 25-26 of this teacher guide for a list of a few Inventors and Innovators provided for students who are unable to select a person to research.

4. Introduce the **Greenwork** reading (pages 24-25) by asking students what they think of when they hear or see the word “green.” They probably already know that green has come to mean much more than a color. Have students’ pair and share their ideas on what they think it means to be “green.” Record their responses.

   Have students read the definition of green jobs in the Power Point! box and ask them to identify green jobs or careers they think would link with some of the categories that are listed.

5. Review the career awareness and exploration projects on page 25 and discuss those the class might implement as
part of this study or as a future school project. Students might also plan a green job fair or an event for Earth Day (or Earth week) that includes careers and jobs in renewable energy fields.

Summarize this section on green jobs and careers by asking students to recall from this study why there are growing opportunities in California and other states related to renewable energy. Review how the smart grid will facilitate the use of more renewable energy resources. Also tell students that California has a goal by 2020 to have 33 percent of all the electricity that is generated coming from renewable energy sources.*

Introduce the Using the Language of Energy Measurement reading and activity by asking students if they know how the school or a family pays for the “power” that they use. Discuss their responses and ask students to turn to and read pages 26 in the activity book. As they read this page students should jot down key points on how natural gas and electricity are measured and billed. Refer them to the Power Point! box that describes the words that are used in measuring the use of electricity and natural gas. Answers to the questions on page 27 can be found in Appendix A.

Ask the principal or the school’s energy manager to discuss any measures that are being taken to reduce energy use and save money on the schools’ natural gas and electric bills. Ask the students to discuss the roles they can have in reducing energy consumption. Responses could include monitoring lights left on in empty rooms, or not opening windows when the heater or the air conditioning (AC) is working.

Students should also identify and discuss ways that the school can shift energy use from non-peak demand times.

Introduce page 28, Greening the School, by asking students to form small groups to brainstorm ideas for environmental projects the class might take during the school year. Students can add to their “ideas” by viewing a Green Squad animation that has numerous school projects for the environment. (www.nrdc.org/greensquad)

Have students turn to the crossword puzzle on pages 30-31. The puzzle can be completed as an open book activity thus allowing students to use the glossary

* California Assembly Bill 32 – Global Warming Solutions Act of 2006 mandates that utilities increase the use of renewable energy sources to generate electricity.
and the readings for assistance in reviewing what they have learned in this study.

Review the answers with the class. (See Answer Key in Appendix A of this guide.)

Summarize this lesson by reviewing the final activities and asking students to return to the introduction on page 1 to determine if the question “Why study about smart energy technologies and the environment?” has been answered for them.

Remind students to take home their completed student activity books to share with parents or guardians.

Extending the Learning:

- **Careers in My Future**
  Students can complete the three activities from the Smart Energy Technologies and the Environment Career Supplement (found in Appendix B). These activities can enhance what students have already learned from the Greenwork reading and activities on pages 24-25.

- **Distributed Generation**
  Students can research how homes, businesses, and government buildings are generating their own electricity using energy sources like solar and wind. As part of their research they could identify examples of distributed energy generation in their own city or geographic region.

- **Shifting our Demand for Energy**
  Students should research and discuss why the demand for energy shifts during peak times during the day. They might begin by asking adult family members why they think that there are peak demand times for energy each day.

  Organize small groups of students to report their findings to the class. Reports should include how peak demand impacts the utilities that are providing the energy. Students should be able to suggest actions that individuals, families, businesses, schools, and other agencies could take to shift their demand for energy to non-peak times.

- **Media Watch — The Evolving Smart Grid**
  Create an ongoing activity having interested students continue to follow the development of the smart grid in the United States. A media watch team of
students could update the class throughout the semester. A U.S. Department of Energy website (www.smartgrid.gov) would be helpful in providing information and additional resources for students.
This list is provided as an additional resource for students in selecting a person to research for the activity on page 23.

- **Paul Allen** (1953- ) founded the Microsoft Corp., a major computer software company, along with Bill Gates. The company’s operating systems are used in the majority of the world’s personal computers.

- **Charles Babbage** (1791-1871) was a mathematician and inventor who also studied philosophy and code-breaking. He designed early mechanical computing devices and pioneered lighthouse signaling and railroad safety devices.

- **Karl Benz** (1844-1929) is credited with building the first automobile powered by an internal-combustion engine. He founded a company that later produced automobiles and a series of race cars.

- **Rachel Carson** (1907-1964) was a marine biologist and nature writer whose book, *Silent Spring*, about the harm created by the overuse of pesticides, helped spur the grassroots environmental movement. Her book led to a ban on the use of DDT and other pesticides.

- **Bill Gates** (1955- ) is a software architect who went on to co-found Microsoft Corp. and become its CEO and spokesperson. Gates is now a leading philanthropist in the areas of education, world health and investment in low-income communities.

- **Robert Goddard** (1882-1945) was a pioneer in the development of rocket technology. He is credited with launching the world’s first liquid-propellant rocket in 1926. NASA’s Goddard Space Flight Center was named in his honor.

- **Jane Goodall** (1934- ) is a leading anthropologist who has devoted her life to studying and understanding endangered species, especially chimpanzees. She established an institute that works to protect chimpanzees at a national park in Tanzania.

- **Stephen Hawking** (1942- ) is a cosmologist and physicist who examines the basic laws governing the universe. He has studied black holes and thinks it possible that the universe has no edges or boundaries. He has written a best-selling book, *The Brief History of Time*.

- **Steve Jobs** (1955-2011) co-founded Apple Computer, Inc. and was responsible for the creation of a number of breakthrough high-tech products, including the Macintosh computer, the IPod, the iPhone and the iPad. Jobs also established a computer animation film studio called Pixar.

- **Hedy Lamar** (1914-2000) was an inventor and a highly successful Hollywood film star. She co-patented a means of sending unbreakable code by radio in wartime, a system which contributed to the later development of digital communications technology.
• **Ada Lovelace** (1815-1852) was an English mathematician who expanded on Charles Babbage’s idea for a “calculating engine” and accurately predicted that it could have many practical and scientific uses. Her plan for how the machine might calculate Bernoulli numbers is recognized as the first computer program.

• **George Lucas** (1941- ) is a film director, writer and producer who created the “Star Wars” film series. He founded the Lucas film studio and has made many important contributions to motion picture technology.

• **Elon Musk** (1971- ) is the co-founder of the electronic payment firm PayPal and the CEO of the electric car manufacturing company Tesla Motors. He has also founded SpaceX, a space exploration company.

• **Isaac Newton** (1643-1727) was a British mathematician whose work established gravity as a universal force in the universe. He also conducted experiments on the composition of light and built a reflecting telescope.

• **Florence Nightingale** (1820-1910) was a pioneering nurse who worked to improve hygiene practices in hospitals. During the Crimean war, her team of nurses saved the lives of many wounded soldiers. Besides improving sanitary conditions, she introduced a number of patient services to improve the quality of a soldier’s hospital stay.

• **Jonas Salk** (1914-1995) was a medical doctor and researcher who developed the polio virus vaccine, which is credited with saving at least one million lives and preventing many more crippling injuries. Dr. Salk also founded an institute for biological studies focusing on developing future generations of scientific researchers.

• **Mary Fairfax Somerville** (1780-1872) was a British mathematician and member of the Royal Astronomical Society. She wrote a number of important scientific book and was an early supporter of women’s education and female suffrage.

• **Nikola Tesla** (1856-1943) invented the first alternating current motor. He also launched the first electric power system and designed the first modern power station, at Niagara Falls.

• **Alan Turing** (1912-1954) was a pioneer mathematician and computer scientist. He led a British team during World War 2 that broke the German secret code. His theoretical “Turing machine” has become the foundation for the theory of computing and computability.

• **Steve Wozniak** (1950- ) co-founded Apple Computer Inc. (later renamed Apple, Inc.). He designed the company’s early line of products and was an important influence in the development of the personal computer industry.
Global Climate Change

"Human activities, such as the release of greenhouse gases from burning fossil fuels are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depends on the understanding of climate science, engineering capabilities, and other kinds of knowledge such as understanding of human behavior and on applying this knowledge wisely in decisions and activities."

— MS-ESS3 Earth and Human Activity, Grade Six

From: Next Generation Science Standards (NGSS) for California Public Schools, Kindergarten–Grade Twelve (adopted by California State Board of Education, September, 2013).
Appendix A
Lesson 1: Energy—Follow the Paths

Page 3 (Four Sectors: Energy Use and Me)

2 Complete the chart by listing under each of the four sectors how you are directly or indirectly consuming energy within that sector.

Answers will vary, but could include:

- Commercial sector: shop at the store, eat at a fast-food place, etc.
- Residential sector: play video games, watch TV, use refrigerator, etc.
- Transportation sector: ride car to school, ride bus to school, take bus or train to visit relatives, etc.
- Industrial sector: buy a smartphone, buy clothes, etc.

Page 5 (You Can Innovate)

1 Read the name of the device below.

2 Answer the questions as best you can.

3 Use the example of the shower to help complete the questions for the other devices.

Answers will vary. Typical answers would address all three elements [A: question/problem; B: new question/problem; C: answers using smart technology] For example:

- Cell Phone
  A. Talk to friends
  B. Baseball coach can’t get through to me when I’m on the phone
  C. Phone beeps when coach is trying to get through

- Refrigerator/freezer
  A. Keeps food cold
  B. Uses a lot of power
  C. Put refrigerator in vacation mode when family is away

Page 10 (Energy Sources: Renewable and Nonrenewable)

3 Discuss as part of your presentation the pros (advantages) and cons (disadvantages) of the energy source or sources your group researched.

Answers will vary. For example:

<table>
<thead>
<tr>
<th>ENERGY SOURCE</th>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>renewable</td>
<td>can be polluting</td>
</tr>
<tr>
<td>Coal</td>
<td>big part of power supply; abundant</td>
<td>nonrenewable; polluting; harms environment</td>
</tr>
<tr>
<td>Geothermal</td>
<td>nonpolluting</td>
<td>limited number of locations</td>
</tr>
<tr>
<td>Hydropower</td>
<td>renewable</td>
<td>dams expensive to build; may harm the environment</td>
</tr>
</tbody>
</table>
### ENERGY SOURCE PROS CONS

<table>
<thead>
<tr>
<th>ENERGY SOURCE</th>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>abundant energy source</td>
<td>nonrenewable</td>
</tr>
<tr>
<td>Nuclear (Uranium)</td>
<td>nonpolluting</td>
<td>nonrenewable; safety questions</td>
</tr>
<tr>
<td>Ocean</td>
<td>renewable</td>
<td>technology not developed</td>
</tr>
<tr>
<td>Petroleum (Oil)</td>
<td>abundant</td>
<td>nonrenewable; polluting</td>
</tr>
<tr>
<td>Solar</td>
<td>renewable</td>
<td>expensive; weather dependent</td>
</tr>
<tr>
<td>Wind</td>
<td>renewable</td>
<td>weather dependent</td>
</tr>
</tbody>
</table>

### Page 13 (Make a Match)

Review what you have read and learned about renewable and nonrenewable energy source. Connect the phrases or sentences below with the correct word or words. To make a match write the correct letter on the lines.

**Answers:**
- h renewable
- m fossil fuels
- o greenhouse gas (GHG) emissions
- j coal
- k distributed generation
- c biomass
- l wood
- e tidal energy
- g geothermal
- f uranium
- d photovoltaic (PV) cells
- n wind farm
- b Hoover Dam
- i hydropower
- a finite

### Lesson 2: Smart and Smarter

### Page 15 (Engineering Achievements)

2 Be prepared to report on at least 10 technologies used at your school that were made possible by electrification.

**Answers** could include common electrical devices like lights, interactive whiteboards, computers, signboards, school kitchen appliances, etc.

### Page 17 (Review, Recall, and Connect)

1 What are five or more factual things you recall about the 2003 power blackout?

**Answers** could include:
- Summertime
- Big demand for electricity
- Largest blackout in U.S. history
- Lasted two days in some places
- Took place in U.S. and Canada
2 How was the electric grid being described at the time of the 2003 blackout?

Answers could include:

- creaky
- faulty
- aging
- overloaded
- dumb grid

3 Review and summarize the text in the Power Point box. Why do you think the author made reference to the Internet?

Answers should reflect the point that the electricity grid is old and that operators do not know what is happening with the grid in “real time.” Moving to a smart grid would be like merging the Internet and the existing “dumb grid.”

4 What are the connections between weather and increased demands for electricity?

Answers should reflect the fact that hot summers create a great demand for air conditioning, and this puts stress on the power grid. (Of course, cold weather also creates a greater demand for power as well.)

Page 19 (Technologies Tasks)

Directions:

1 Select a task from one of the screens.

Answers will vary.

Page 21 (How Smart is Your World?)

1 Develop a list of “smart” devices that you use in your life.

Answers could include some of the following devices:

- Smart phones
- Tablet computers
- Smart cards
- Smart meters
Lesson 3: Power Connections—Learning and Exploring

Page 27 (Where Does the Money Go?)

Analyze the bar graph and what you have read about measurement to complete the following:

1. In an average home 14% of a utility bill is for heating water and another 29% for space heating. An average California home would pay $1600 annually for these heating functions.

2. Lighting and electronics in an average home account for 16% of a utility bill. These two items would yearly cost an average California family $256.

3. What are six or more energy-saving personal actions you could suggest to a family to consume less energy and save money?

   Answers could include:
   - Efficient appliances
   - Efficient lighting
   - Motion light sensors
   - Turn off lights when not in use
   - Set air conditioning at a higher temperature
   - Energy efficient windows

4. What energy-saving “technologies” would you recommend to be installed at your school?

   Answers could include:
   - Efficient lighting
   - Motion light sensors
   - Turn off lights when not in use
   - Energy efficient windows
### California Common Core Standards*

#### Smart Energy Technologies and the Environment Correlations for Grade 6

<table>
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<th>Common Core Standards</th>
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<tr>
<td><strong>Reading Standards for Informational Text (RSIT)</strong></td>
<td><strong>Energy: Follow the Paths</strong></td>
<td><strong>Smart and Smarter</strong></td>
<td><strong>Power Connections: Learning and Exploring</strong></td>
</tr>
</tbody>
</table>
| **6.RSIT.1.** Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. | Students:  
- reference text on Technologies Bring us Electricity in order to discuss and analyze the technology of a turbine generator in a power plant.  
- reference informational text from a activity book when discussing environmental impacts of energy generation from fossil fuels. | Students:  
- cite informational text from A Great Engineering Achievement and speculate on what would be included on a list for the 21st century  
- reference informational text from Wanted: A Smarter Grid and infer where this discussion is leading in this study. | Students:  
- make assumptions on energy savings as part of “reading a utility bill” and accompanying text on the language of energy measurement. |
| **6.RSIT.2.** Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments. | Students:  
- summarize central idea of text on energy consumption by the four sectors in the economy.  
- read and summarize text providing details on the path electricity takes to reach where it is used. | Students:  
- analyze, summarize and cite text on the central ideas in readings on the smart grid and related evolving technologies. | Students:  
- summarize text that focuses on the power of imagination by citing examples in the reading  
- cite text on green careers when analyzing what makes a job or career green. |
| **6.RSIT.3.** Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes). | Students:  
- explain (and are aware) how individuals like Alexander Bell, William Stanley Jr. and Thomas Edison are introduced in the text (e.g., historical references, quotes, etc.). | Students:  
- analyze how the idea of great engineering achievements is used to focus on the importance of electrification. | Students:  
- analyze how four famous individuals are used to illustrate the “power of the imagination” and to test the power of their own imagination. |
| **6.RSIT.4.** Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings. | Students:  
- discuss the broader “meaning” of technology and provide examples.  
- “Make a Match” word / phrase activities on energy sources. | Students:  
- recall new vocabulary in context of readings on the evolving smart grid and the technologies in their own lives. | Students:  
- recall words and phrases in order to complete the Crossword Grid. |

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* California Common Core State Standards for English-Language Arts & Literacy in History/Social Studies, Science and Technical Subjects (Adopted by the California State Board of Education August, 2010 and modified March, 2013)
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<tr>
<td><strong>6.RSIT.6</strong>. Determine an author’s point of view or purpose in a text and explain how it is conveyed in the text.</td>
<td>Students: • determine the overall purpose of text as they read page 1 of the opening section in activity book on Why Study about Smart Energy Technologies?</td>
<td>Students: • analyze the point of view expressed in the reading on the great power blackout of 2003 (Wanted: A Smarter Grid)</td>
<td>Students: • Discuss the reason for including text on green jobs and careers.</td>
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<tr>
<td><strong>6.RSIT.7</strong>. Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.</td>
<td>Students: • integrate graphic and textual information on the generation and path of electricity to complete group tasks; e.g., pages 7-9 • use information from text and a bar graph on energy consumption to understand how they too are consumers in of energy in all the sectors.</td>
<td>Students: • read text, analyze photos and visit websites to research the extent and impact of the 2003 blackout (e.g., demonstrated the need for an updated and smarter electric grid).</td>
<td>Students: • combine information from a pie chart, a utility bill, and text to analyze how energy is measured and consumers are billed for the electricity and natural gas they use.</td>
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<td>Writing Standards (WS)</td>
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<tr>
<td><strong>6.WS.2</strong>. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization and analysis of relevant content.</td>
<td>Students: • Write a clear response /answer to the question of why fossil fuels are a nonrenewable energy source. • develop a written response that supports the idea that life as we know it on Earth would not be possible without the greenhouse effect. (Bonus activity)</td>
<td>Students: • develop written responses to activities throughout lesson two that are clear and can be supported by evidence (e.g., lesson two activities include writing on the smart grid, smart meter, and smart devices in our lives).</td>
<td>Students: • develop written responses to activities throughout lesson three that are clear and can be supported by evidence.</td>
</tr>
<tr>
<td><strong>6.WS.2a</strong>. Introduce a topic or thesis statement; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.</td>
<td>Students: • Organize individual and group presentations related to their study of energy sources and environmental issues utilizing a range of strategies and visuals (e.g., charts, illustrations, videos, PowerPoint presentations, etc.).</td>
<td>Students: • Organize individual and group presentations related to great engineering achievements, technologies in our lives, etc., by utilizing a range of strategies and visuals (e.g., charts, illustrations, videos, PowerPoint presentations, etc.).</td>
<td>Students: • Organize individual and group presentations utilizing a range of strategies and visuals. Topics relate to the power of the imagination, greening the school, etc.</td>
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### California Common Core Standards *(continued)*

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<td><strong>Smart and Smarter</strong></td>
<td><strong>Power Connections: Learning and Exploring</strong></td>
</tr>
</tbody>
</table>
| **6.WS.6.** Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others. | Students:  
- use the Internet to write reports and to collaborate on group projects on energy generation, energy sources, and innovation tasks. | Students:  
- use the Internet to write reports and to contribute information to group projects on great engineering achievement smart technologies in our lives, etc. | Students:  
- collaborate as they use the Internet to write about *greening the school* project ideas for the school year. |
| **6.WS.7.** Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate. | Students:  
- conduct research as part of study of how technology brings us electricity, energy generation, fossil fuels, and responses to the costs and benefits of various energy sources. | Students:  
- conduct research related to individual or group activities on topics covered in lesson two (e.g., the smart grid, etc.). | Students:  
- select related topics to research as an enrichment activity  
- conduct research on green jobs and careers related to renewable energy fields. |
| **6.WS.8.** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources. | Students:  
- compile information from digital and print sources as part of project activities in lesson one. (Students are asked to list sources of information they use.) | Students:  
- compile information from digital and print sources as part of project activities in lesson two. (Students are asked to list sources of information they use.) | Students:  
- compile information from digital and print sources as part of project activities in lesson three. (Students are asked to list sources of information they use.) |
| **6.WS.9.** Draw evidence from literary or informational texts to support analysis, reflection, and research. | Students:  
- use informational text on energy sources (in section of activity book) to analyze the pros and cons of each source. | | |
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<tr>
<td><strong>Speaking and Learning Standards (SLS)</strong></td>
<td><strong>Energy: Follow the Paths</strong></td>
<td><strong>Smart and Smarter</strong></td>
<td><strong>Power Connections: Learning and Exploring</strong></td>
</tr>
<tr>
<td><strong>6.SLS.1.</strong> Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others’ ideas and expressing their own clearly.</td>
<td>Students:</td>
<td>Students:</td>
<td>Students:</td>
</tr>
<tr>
<td></td>
<td>• participate in group projects by “actively” contributing to discussions and overall presentations to the class (e.g., You Can Innovate, etc.).</td>
<td>• engage in group projects by “actively” contributing to discussions and presentations to the class (e.g., Technologies in My Life, How Smart Is Your World, etc.).</td>
<td>• “collaborate with students in small and whole group activities to select and conduct greening the school projects.”</td>
</tr>
<tr>
<td><strong>6.SLS.2.</strong> Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.</td>
<td>Students:</td>
<td>Students:</td>
<td>Students:</td>
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<tr>
<td></td>
<td>• Interpret information presented visually on the journey of electricity from source to homes and other buildings (e.g., also discuss how graphics will enhance their own presentations).</td>
<td>• use and interpret information presented in a range of ways to help explain the need for a smart grid and what makes a technology “smart.”</td>
<td>• interpret a bar graph on what average households pay for in terms of energy use (e.g., by percentages).</td>
</tr>
<tr>
<td><strong>Reading Standards for Literacy in Science &amp; Technical Subjects (RST)</strong></td>
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<tr>
<td><strong>6-8.RST.1.</strong> Cite specific textual evidence to support analysis of science and technical texts.</td>
<td>Students:</td>
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<td>Students:</td>
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<td></td>
<td>• cite specific text on voltage, substations and transmission lines when discussing the “travels” of electricity.</td>
<td></td>
<td>• read and cite text from Using the Language of Energy Measurement as they discuss the activity and bar graph on page 27.</td>
</tr>
<tr>
<td><strong>6-8.RST.3.</strong> Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.</td>
<td>Students:</td>
<td></td>
<td>Students:</td>
</tr>
<tr>
<td></td>
<td>• follow a detailed procedure to conduct an experiment on greenhouse gas emissions. (Extension activity)</td>
<td></td>
<td>• recall specific words, key terms and symbols as they complete the Crossword Grid activity.</td>
</tr>
<tr>
<td><strong>6-8.RST.4.</strong> Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.</td>
<td>Students:</td>
<td>Students:</td>
<td></td>
</tr>
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<td></td>
<td>• determine that symbols are used for chemical elements in the topics they are studying; e.g., carbon dioxide (CO₂). Also students learn the meaning of greenhouse gas (GHG) emissions, global climate change, uranium and other scientific terms.</td>
<td>• determine and use key terms in lesson two activities (e.g., outages, blackouts, smart grid, sensors, digital technology, analog, smart meter, etc.).</td>
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<tr>
<td>Common Core Standards</td>
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<td><strong>ACTIVITIES</strong></td>
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<tr>
<td>Reading Standards for Literacy in Science &amp; Technical Subjects (RST)</td>
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<tr>
<td>6-8.RST.6. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.</td>
<td>Students: • analyze the purpose of the text that explains end energy use by economic sectors in the economy.</td>
<td>Students: • discuss how the text and visuals on energy sources (in Section II of activity book) reflect the overall purpose of the study.</td>
<td>Students: • analyze the purpose of text and activities on green careers as they relate to an understanding of renewable energy.</td>
</tr>
<tr>
<td>6-8.RST.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).</td>
<td>Students: • use technical information on electricity production and distribution that is presented in text, and diagrams to complete a range of activities. • use both technical/historical information (text and diagrams) to complete group and individual projects suggested in Lesson 1.</td>
<td>Students: • use technical information, charts, diagrams, and illustrations on ten energy sources to complete a range of activities. • combine technical information (from text and visuals) to analyze and develop a chart on the pros and cons of energy sources studied in this unit.</td>
<td>Students: • integrate information from text, a chart, and a visual to explain how energy (electricity and natural gas) are used and measured in therms and kilowatt-hours.</td>
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<tr>
<td>Writing Standards for Literacy in History/Social Studies, Science &amp; Technical Subjects (WHST)</td>
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<tr>
<td>6-8.WHST.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</td>
<td>Students write: • a timeline on the electrification of the United States beginning with 1882 — the first US power plant was opened in New York city. • Informative responses to explain environmental impacts of various renewable and nonrenewable energy sources.</td>
<td>Students: • explain in written reports (individual and group) basic technical information related to great engineering achievements, the electric grid, the need for a smart grid, etc.</td>
<td>Students write: • responses to a series of questions related to where household money goes for electricity and natural gas. • clear responses on how consumers can save energy and also shift time of use (e.g., demand response).</td>
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<tr>
<td>Common Core Standards</td>
<td>Lesson One</td>
<td>Lesson Two</td>
<td>Lesson Three</td>
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<tr>
<td>Writing Standards for Literacy in History/Social Studies, Science &amp; Technical Subjects (WHST)</td>
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</table>
| 6-8.WHST.6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently. | Students:  
- Use the Internet to facilitate their written responses to activities in lesson 1. This includes an EPA student site on global climate change, an Energy Information Administration (EIA) site on energy sources and an intro to the electric grid. (www.smartgrid.gov). | Students:  
- use the Internet in preparing reports related to the suggested activities in lesson two (e.g., smart grid — why needed, etc.). | Students:  
- access the Internet to research and write reports on topics of their own choosing.  
- use and report on websites that can help them implement green projects at their schools. |
| 6-8.WHST.9. Draw evidence from informational texts to support analysis, reflection, and research. | Students:  
- use informational text found in lesson 1 of activity book to help them with analysis and research on topics related to energy sources and environmental impacts of energy production and use.  
- use informational text in lesson 1 of activity book to research and analyze the advantages (pros) and disadvantages (cons) of ten energy sources (e.g., drawing evidence to support this pro and con activity). | Students:  
- use informational text in student activity book readings (pages 14–21) to complete suggested writing activities and/or as an introduction to topics requiring additional research. | Students:  
- draw from informational text to summarize and reflect on the opening question in this unit of study (Why Study about Smart Energy Technologies and the Environment?) |
## Next Generation Science Standards*

**Smart Energy Technologies and the Environment Correlations for Grade 6**

<table>
<thead>
<tr>
<th>Next Generation Science Standards (NGSS)</th>
<th>Lesson One</th>
<th>Lesson Two</th>
<th>Lesson Three</th>
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</thead>
<tbody>
<tr>
<td>Disciplinary Core Ideas</td>
<td>Energy: Follow the Paths</td>
<td>Smart and Smarter</td>
<td>Power Connections: Learning and Exploring</td>
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<tr>
<td>MS. Weather and Climate</td>
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<tr>
<td>ESS2.C: The Roles of Water in the Earth’s Surface</td>
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<tr>
<td>MS-ESS2.6. Variations in density ... drive a global pattern of interconnected ocean currents.</td>
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<tr>
<td>ESS2.D: Weather and Climate</td>
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<tr>
<td>MS-ESS2.6. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms and living things. These interactions vary... and can affect oceanic and atmospheric flow patterns.</td>
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### Lesson One: Energy: Follow the Paths

**Students:**
- relate the patterns of movement of water in the atmosphere to their study of wind power and ocean energy.
- research forms of ocean energy and relate this to the worldwide pattern of interconnected ocean currents.

### Lesson Two: Smart and Smarter

**Students:**
- visit an EPA kids website to learn about global climate change and read text on how air pollution and greenhouse gas (GHG) emissions are contributing to global climate change.
- read text and research the impacts on the environment of burning fossil fuels (e.g., heat-trapping gases are warming the planet).

### Lesson Three: Power Connections: Learning and Exploring

**Students**
- Select an optional research activity related to various energy sources including wind and ocean energy.

*Next Generation Science Standards (NGSS) for California Public Schools, Kindergarten–Grade Twelve (adopted by California State Board of Education, September, 2013),*
Next Generation Science Standards (NGSS) | Lesson One Energy: Follow the Paths | Lesson Two Smart and Smarter | Lesson Three Power Connections: Learning and Exploring
--- | --- | --- | ---
**Disciplinary Core Ideas** | **ACTIVITIES** | **Crosscutting Concepts** (Influence of Science, Engineering, and Technology on Society and the Natural World)

**MS. Weather and Climate**

**ESS3.D Global Climate Change**

**MS-ESS3.5.** Human activities such as the release of greenhouse gases from burning fossil fuels are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.

**Students:**
- study how energy production from fossil fuels produces air pollution and greenhouse gases that contribute to global climate change.
- analyze a pie chart on greenhouse gas emissions by economic sectors.
- conduct an experiment on the greenhouse effect and discuss how this experiment can help explain the greenhouse effect and the warming of the planet.
- visit a web site to learn about the effects of global climate change (www.epa.gov/climatechange/kids).

**Students:**
- review both the pros and cons of using fossil fuels as an energy source to generate electricity (e.g., students research the costs and benefits of all the energy sources).

**Students:**
- can select a research topic to learn more about global climate change.
- select a class project (e.g., greening the school) that will encourage energy-saving behaviors and reduce greenhouse gas emissions that contribute to global climate change.

**Crosscutting Concepts**

**MS-ETS1.1.** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

**Students:**
- learn throughout the Energy Sources and Environment lessons how our natural resources are limited and must be conserved. They discuss (in context of energy use and energy production) the consequences on people and the environment.
- analyze use of energy in economic sectors of our economy and discuss what energy (electricity and natural gas) provides and impacts of use.

**Students:**
- learn throughout the lessons how our natural resources are limited and must be conserved. They discuss (in context of energy use and energy production) the consequences on people and the environment.
- discuss the positive use of energy in their daily lives and discuss what energy (electricity and natural gas) provides for them and their families.

**Students:**
- analyze a utility bill to understand the use of energy in their daily lives and discuss what energy (electricity and natural gas) provides for them and their families.
### Next Generation Science Standards \textit{(continued)}

<table>
<thead>
<tr>
<th>Next Generation Science Standards (NGSS)</th>
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<tr>
<td><strong>Crosscutting Concepts</strong></td>
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<tr>
<td>Influence of Science, Engineering, and Technology on Society and the Natural World</td>
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<tr>
<td><strong>MS. Ecosystems: Interactions, Energy, and Dynamics</strong></td>
<td>Students:</td>
<td>Students:</td>
<td>Students:</td>
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<tr>
<td>MS-LS2-5. The uses of technologies and any limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.</td>
<td>• read informational text on how the technologies they use required innovation (solving problems in new ways).</td>
<td>• read and research information on innovators (past and present) and discuss how their inventions built upon earlier work done by others.</td>
<td>• complete an activity on the” power of the imagination” and discuss any present limitations they discovered (e.g., imagining things that could be possible in the future). Students can reference (from Lesson 2) a writer like Jules Verne).</td>
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<tr>
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<td>• analyze how devices we use to-day were built upon earlier innovations.</td>
<td>• analyze why electrification was considered the greatest engineering achievement of the 20th century.</td>
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<td>• discuss how technologies are driven by various needs (individual or societal) and by other factors along with the appropriate research.</td>
<td>• read the discuss the need for an updated and smarter grid and analyze the “technologies” that will be used as this grid evolves.</td>
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<td></td>
<td>• follow the path of how technologies bring electricity to our homes, schools, and businesses.</td>
<td>• complete an activity to identify technologies in their own lives and the “needs” they fill.</td>
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</table>
Educational Resources

from Pacific Gas and Electric Company (PG&E)

www.pge.com/energenius

The Energenius® Education Series for Preschool–Middle School

Pacific Gas and Electric Company’s Energenius Educational Series provides engaging, educational programs that teach preschool, elementary, and middle school students about energy, the environment, and the conservation of natural resources. If you are an educator in Pacific Gas and Electric Company’s service territory, you qualify to receive Energenius instructional materials without charge.

Energenius programs offer students:
- Colorful posters, activity books, and calendars.
- A sense of empowerment to impact their environment in a positive way.

Energenius offers educators:
- Clear, detailed lesson plans.
- Field-tested materials with activities that correlate with Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS)
- Activities to teach students about energy sources and ways to protect and conserve resources.

THE EARTH CAN ALWAYS USE MORE ENERGENIUSES! Help students understand how they use energy in their homes and schools, and how they can take positive actions to save energy, conserve natural resources, and protect the environment.

Order your free materials online at www.pge.com/energenius.

Also visit the Online Energy Resources at www.pge.com/educationalresources to discover a number of web-based resources.
**Glossary**

**advanced metering**
Electricity meters that use two way communication between a utility and its customers.

**blackouts**
A loss of power affecting many electricity customers over an extended period of time and spread across a large area.

**climate change**
Refers to any significant change in measures of climate (such as temperature, precipitation, wind) lasting for an extended period of time (decades or more). [www.epa.gov/climatechange/basic.info](http://www.epa.gov/climatechange/basic.info)

**demand response**
Programs and ways that energy companies (utilities) and consumers can better manage when and how they use energy. Using less energy during peak demand hours is an example of demand response.

**distributed energy generation**
(Also called distributed generation (DG). The generation of electricity near to the place where it is being used. On-site distributed generation examples include a school powered by solar panels, a farm powered by its wind turbines, an office building powered by fuel cells.

**electric grid**
All the networks that carry electricity from power plants to where it is used. The grid includes power lines, substations, transformers, distribution wires and more.

**electrification**
A term to describe how electricity gets from a power plant to energy consumers.

**energy efficiency**
The use of energy without waste. Energy efficiency refers to work done using the smallest amount of energy needed.

**fossil fuels**
Fuels formed from the remains of plants and animals that lived over 70 million years ago. Coal, oil, and natural gas are fossil fuels.

**generator**
A device used to convert mechanical energy to electrical energy.

**global warming**
Global warming is an average increase in the temperature of the atmosphere near the Earth’s surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, “global warming” often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities. [www.epa.gov/climatechange/basic.info](http://www.epa.gov/climatechange/basic.info)

**goods**
Something used or consumed. The foods we eat and the clothes we wear are goods.

**green**
A color. Green can also be used to mean a person or process that helps protect or is “friendly” to the environment.

**greenhouse effect**
The effect produced when greenhouse gases trap solar radiation in the Earth’s atmosphere and warm the planet. This process occurs naturally and has kept the Earth’s temperature about 60 degrees Fahrenheit warmer than it would be without it. Current life on Earth could not continue without the greenhouse effect. [www.energystar.gov/index.cfm?c=kids.kids_index](http://www.energystar.gov/index.cfm?c=kids.kids_index)

**greenhouse gas (GHG)**
A gas, such as carbon dioxide (CO₂) or methane (CH₄), that traps the heat of the sun in the Earth’s atmosphere.

**green jobs**
Careers or jobs that focus on protecting the environment and conserving natural resources.

**innovation**
A new idea, device, or method. The introduction of something new.

**kilowatt**
A unit of measurement of electric power that equals 1,000 watts.

**kilowatt-hour (kWh)**
A unit of measurement of electricity used which translates to one kilowatt used for one hour.
megawatt
A unit of measurement of electrical power equal to one million watts or 1000 kilowatts.

nonrenewable energy
A resource such as coal or oil that cannot easily be replenished. They were formed over millions of years ago.

outage
A period of time when a power supply is not available.

peak demand
The times during the day when the demand for electricity is the highest. This period of the day is between noon and 7:00 p.m.

petroleum (oil)
A natural, thick, flammable liquid made of the remains of plants and animals that lived over 70 million years ago.

pollution
Impurities in air, water, and land that create an unclean environment.

power plant
A place where energy is generated.

renewable energy
An energy source such as solar or wind that can be restored by nature after it is used.

sector
A new idea, device, or method. The introduction of something new.

sensors
A device that detects or measures something and then responds to it. A motion-sensor detects when someone enters or leaves a room and responds by turning lights on or off.

services
A thing done for you by someone else, like a swimming lesson, a haircut, or a medical exam.

smart grid
A modernized electric grid. Will include technologies for two-way interaction between consumers and utility companies. Also allow for distributed generation and an increased use of renewable energy sources.

smart meter
An automated two-way communications system between a utility and its customers. Smart meters can measure and record the electricity used by a customer in “real time.”

technology
The application of scientific or engineering knowledge to a certain area. “High technology” refers to advanced scientific methods and materials, especially those involving computers and electronic devices.

therm
A measurement of the amount of natural gas that is used.

utility
An agency or company that supplies electricity, natural gas, water or phone service.
Career Awareness
Career awareness is about discovering the “possibilities” that could exist in a student’s own future. Career awareness activities at the elementary and middle school levels introduce students to a range of careers, and to skills, education, and training needed for them. Career awareness activities help students make connections between what they study in school and a future world of work.

Students should have opportunities for career exploration by taking field trips, as age appropriate, to see workers in action. Inviting women and men working in specific occupations to speak to the class can also help “spark” an interest in a future job or career. Virtual field trips and career focused YouTube videos can extend awareness activities for students.

As part of this Energenius program students were introduced to green jobs in the Greenwork activity. They learned that green jobs are ones that provide goods or services that benefit the environment and/or conserve natural resources. Students discovered that many green jobs are created as workers in existing occupations gain new skills. In the energy sector, for example, electricians are being trained or retrained to install solar panels on the roofs of homes and businesses. Workers in the energy utility sector are being trained on the technologies that will comprise an evolving smart grid. Increasingly in the U.S. houses and other buildings are being designed to meet specific energy efficiency standards in how they are built, heated, lit and cooled. To meet these standards construction workers are now being trained with new skills to meet these energy efficiency requirements.

There will be many ways for your students to work green in the future. Some of these jobs and careers will be found in the fields of energy efficiency, renewable energy sources and the evolving smart grid.

ACTIVITY ONE: A View From the Roof .................... 2–3
ACTIVITY TWO: Stepping Up for Action ................. 4–5
ACTIVITY THREE: Your Green Media Watch .......... 6

The above activities can be easily copied for individual student use.
In this unit you learned about renewable energy sources and how the sun’s power was used to generate electricity. You discovered how solar cells convert sunlight into electricity and how solar cells are used to power small devices like calculators and cell phone chargers. You might have also seen actual large solar panels installed on roofs near your school. As part of your study you also learned about distributed generation (DG), DG is electricity produced at or near the point where it is used. Solar panels on rooftops or mounted nearby are examples of electricity generated near to where it is being used.

In this interview with an installer of solar photovoltaic (PV) panels you will learn more about one job in the solar industry.

Q. Where do you do most of your work as an installer of PV panels?
A. All of my work is on the roofs of homes. Although there are other PV installers who work at businesses, factories, and at schools.

Q. What is a typical day for you?
A. A typical workday begins before the actual installation. First, an installer needs to determine if the roof can hold the weight of the solar panels and if there enough room for panels. Another typical day is when the framed solar panels are bolted to the roof and are connected with wires. Depending on the size of the roof a job could take many days to complete.

Q. What are the skills needed for your job?
A. Someone should certainly not be afraid of heights. Installers should be able to work with power and hand tools and have problem-solving and mechanical skills. Lifting is also required as solar panels can be heavy. Installers must pay attention to details, as they need to follow diagrams and instructions.

Q. Do you have to be an electrician to do this job?
A. No, not always. But a licensed electrician must complete the part of the installation when the wiring is connected to a utility box and main electrical grid. Some cities in the U.S. also require that only licensed electricians can be solar panel installers.

Q. Would you call your job a green job?
A. Definitely yes! These solar panels I install are generating “clean” energy coming from the sun. They are not polluting the atmosphere or emitting greenhouse gases that contribute to global climate change.

Q. How can we find out more about the job of a solar PV installer?
A. I suggest you visit a U.S. Department of Labor website for more information: www.careeronestop.org
Your teacher might also suggest a YouTube video to explain the job of a solar installer or to learn more about distributed generation.
Our Q and A Interview

Directions:

1. Organize in small groups to complete this activity.

2. Select and research a job or career in a renewable energy field that interests your group.

We selected:

__________________________________________________________________________
__________________________________________________________________________

3. Use your research to develop a Q and A interview with a “hypothetical” person with a job in the field you selected.

4. Role play this interview for the rest of the class. Be prepared to answer additional questions classmates might have about the job.

5. List below websites and other resources you used to prepare your Q and A interview.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
ACTIVITY TWO: Stepping Up for Action

Students all around the United States are taking on “green” projects at their schools and in their communities. The actions of students can help reduce our use of energy, water and help conserve natural resources. These green actions will help you learn about the “jobs” it takes to plan, implement, and conduct their projects.

Directions:
1. Work in small groups to review and discuss some of the suggested projects on this page.
2. Be ready to join a discussion on the pros and cons of each project.
3. Develop a list of tasks (on the next page) for the project or projects your class has selected.

<table>
<thead>
<tr>
<th>Select a project!</th>
<th>Define your job!</th>
<th>Step up for action!</th>
</tr>
</thead>
</table>

**Environmental Auditors**
Does your school reduce, reuse, and recycle? Does your cafeteria compost food waste? Are there motion sensors in classrooms? Are there water sensors in the lavatories? Develop a plan to audit where energy, water, and other natural resources are being wasted in your school. Make a list of recommendations to present to the school principal and later to the school board in your district.

**Clean Air Monitors**
The job for these monitors is to improve the quality of air around the school. Vehicle exhaust is a big contributor to air pollution. A good start for cleaner air around your school is to develop a no-idling zone. It begins with writing recommendation and rules to accomplish a zone where people will not leave vehicles running while they are waiting for parking or to pick up students. The no-idling zone focuses on family members dropping and picking up students, and on school bus drivers. Idling cars and buses get zero miles to the gallon and pollute the air.

**Career Day Event Planners**
The tasks for these planners are to organize, promote, and implement a career day program to help students think about the range of jobs that people have. Planners might decide to conduct a career day that focuses on a World of Green jobs. A green jobs theme would provide a “roadmap” for selecting speakers and participating agencies and for promoting the event. To enhance this study on energy technology, a utility representative could speak on future jobs and the smart grid.
Taking Actions for the Environment

Directions:
Complete this page after your group has selected a project to organize and implement this school year.

1. What is the name of your project? ________________________________________________

2. Make a list of tasks (jobs) that will need to be conducted for your project. Next to the task write a job title. For example the task of creating posters is a job for a graphic designer. The person who writes about your selected project for the school newspaper has the job of a journalist.

<table>
<thead>
<tr>
<th>Tasks (Job)</th>
<th>Job Title</th>
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ACTIVITY THREE: Your Green Media Watch!

GOING GREEN GAZETTE
Energy News: A Special Edition

Renewables in California - It is the Law
The state of California has passed laws increasing the amount of renewable energy sources that must be used to generate electricity. By the year 2020, California law mandates that 33 percent of all electricity generated in the state must come from renewable energy sources. These renewable sources include biomass, geothermal, hydroelectric, solar, and wind. Information on how well the state is doing in meeting these renewable goals can be found on the California Energy Commission website. (www.energy.ca.gov)

Renewable Energy Standards in the United States
California is not the only state to have passed laws mandating that utilities increase the amount of renewable energy sources used to generate electricity. At present, over half of the states have mandated standards. There are wide differences in the renewable standards that have been set. Other examples of energy standards include Washington state with a goal of 15 percent renewables by 2020 and Nevada with a goal of 25 percent renewables by 2025. A goal of 12.5 percent renewables by 2025 was set by Ohio.

Information on how California and other states are doing in meeting their renewable goals can be searched at a Department of Energy website. (www.eia.gov)

Directions:
1. What is the renewable energy standard that California is trying to reach by 2020? _______________________

2. What are reasons you think there are varying renewable energy goals and the amount of years given to meet them?
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

3. Select one of the following topics to research and write an article for Going Green Gazette. Be ready to share your article with the class.
   a) A California Update: Meeting 33 Percent by 2020
   b) The Present Energy Source Mix in California
   c) Green Careers Growing in Renewable Energy
   d) Distributed Energy Generation: The Basics