Teacher’s Guide

Transportation, Energy, and the Environment
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“Learning never exhausts the mind.”

Leonardo da Vinci

[1452–1519]
Introduction and Overview

“...This content should be taught so that students have the opportunities to build connections that link science to technology and societal impacts, populations, natural resources, environmental quality, natural and human-induced hazards and other global challenges.”*

Transportation, Energy, and the Environment is an educational program designed to help young people build some of these connections. The links between our daily use of energy, its production, and environmental impacts are not always easily understood. This educational program help students make these connections as they focus on their own daily use of energy. They will consider their own transportation choices and identify how they move each day from one place to another. As they focus on what fuels these journeys, students discover that most transportation is fueled by oil, a fossil fuel. As this study continues they learn the connection between the energy generated by fossil fuels to an increase of greenhouse gas emissions that contribute to global climate change.

Cleaner and Greener

Students discover the technological innovations and alternative fuels that are allowing cleaner and greener vehicles to be manufactured. Activities focus on existing and emerging alternative-fueled vehicles. As they research, a range of vehicles they consider the pros and cons of each and discuss their findings with the class.

Thinking Outside the Car

Lesson and activities help students understand how vehicles on the road release pollutants into the air. They learn how harmful pollutants and smog can be. At www.airnow.gov they insert the zip code of their school and get real-time local air quality conditions. To extend the learning they play smog-city2, an interactive game at the same website.

Throughout this study the benefits of “clean air” activities like walking and biking are discussed. Students will think outside the private vehicle as they discuss carpooling, vanpooling, and public transportation options. They take actions by selecting school projects, like no-idling zones, a walking school bus, a bike safely to school campaign, or a carpooling hot line.

Go Global

A large, colorful, two-sided poster — Go Global — is provided to each student at the end of this study. The poster is designed as a take-home material for parents and guardians. It helps review what students have learned in the class, as well as offering energy-saving tips and actions that family members can take to protect the environment.

Connecting to the California 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 curriculum, along with the accompanying 44-page student activity book, suggested Road Forward extension activities, and a career awareness supplement provide a myriad of exciting learning opportunities.

*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.
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

The student activity book opens with a question that will be answered, as the class becomes actively involved with this program: Why study about transportation, energy and the environment? Lesson 1 is divided into two parts — the first part focusing on how students “get around” and what fuels their travels.

Part 2 of this lesson takes a more global view, which helps students understand the environmental impacts of transportation choices. Research projects and hands-on experiments will help broaden their understanding of the connections between transportation, energy, and the environment.

Teacher Background

The lesson opens with a broad definition of “transportation” as getting from one place to another. As students progress through lesson one activities they will learn what fuels these journeys and the environmental impacts of transportation choices. At various stages of the lesson, the point is made that today most vehicles in the United States are fueled by petroleum (oil) which is a fossil fuel. When energy is generated from fossil fuels, greenhouse gases are generated which contribute to global climate change.

Student activities include interpreting pie charts on energy use by transportation sector and on the sources of greenhouse gas emissions in the United States. They learn about smog and pollutants and in real time determine the air quality around their own school.

For further discovery, the Leaning More research topics on page 13 will provide an opportunity for students to make additional global connections.

Student Objectives

- Students write, discuss, and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy).
- Students review and discuss what they have learned about greenhouse gases, climate change, and global warming.
- Students integrate smog data presented in Environmental Performance labels with print and digital text.
- Students conduct a scientific experiment to write about and explain the greenhouse effect.
- Students use and list web-based resources to research topics about climate change and global warming.

Materials

Provided:

Needed:
- For Earth and Its Atmosphere Experiment (page 11)
  - Two glass jars
  - One measuring cup
  - 10 ice cubes
  - Two thermometers
  - 1 plastic bag

Time Needed

Two to three class periods
climate change
Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer).

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.

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 greenhouse gases from human activities.

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

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

internal combustion engine
A device in which the fuel is ignited and burned within a combustion chamber, producing mechanical energy.

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

petroleum
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.

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

smog
A form of air pollution visible in the air as a brownish-yellow haze. Smog is caused by a buildup of either ground-level ozone or tiny particles of soot known as particulate matter (PM). Smog can form almost anywhere large amounts of air pollution are released.
Procedures

Part 1: Fueling our Journeys

1. Write the following on the whiteboard/smartboard: “How did I get here today?” Explain to the class that when we talk about using transportation to “get somewhere,” there are many possible responses, and they don’t all involve vehicles. Poll your students to identify how they got to school today. Students might wonder why you are asking. Distribute to each student a copy of the activity book and announce that the class will be studying about transportation and the links to energy and the environment. Have students read page 1 of the student activity guide, which tries to answer the question of “why” study about transportation, energy, and the environment. Ask students to add their own answers to the why question.

2. Have students read page 2, Getting from Here to There, and then complete the chart on page 3. Tell them to use “home” and “school” only once under Starting Place for My Travels and My Destinations. The chart is limited to recording a maximum of five trips (even though they may have taken many more). Remind them that biking and walking are forms of transportation.

Students should be prepared to respond to questions about fuel types. School buses, for example, run primarily on diesel fuel, not gasoline. Some cars today, run on electricity, not gasoline. Walking is fueled by one’s own energy.

3. Read and discuss Fueling Our Journeys on page 4 and have students work in small groups to discuss what they discovered from the reading. Students are asked to recall five or more things and then to select a topic to research and present to the class. See Answer Keys in the Appendix for sample answers to this activity Encourage students to use charts, diagrams, and online videos to help explain their topics.

4. Introduce page 6, Air Quality and Pollutants, and ask students to describe a smoggy day in the most vivid way they can. Point out that smog (sometimes called ground level ozone) is caused by pollutants from the burning of fossil fuels. Often smog appears as a brownish-yellow or pinkish haze. It can be caused by a buildup of either ground-level ozone, or tiny particles of soot known as particulate matter. In California, smog is at its worst during periods
LESSON ONE ■ GETTING AROUND

of warm, sunny weather. Ask students if they or someone they know has reacted badly to smog (e.g., watery eyes, allergic reactions, etc.)

Explain that air pollution has many sources, including power plants, factories, and manufacturing processes. However, transportation vehicles like cars, trucks, bulldozers, and trains provide the largest single source of air pollution in the U.S.

Have students visit www.airnow.gov and put in the zip code of the school to see local air quality in real time. As an extension students can play Smog City 2, an interactive game at www.smogcity2.org.

Instruct students to turn to page 7 of the activity book. Since 2009 an Environmental Performance Label (EP Label), similar to the one shown, must be posted in the window of all new cars sold in California. They give vehicles both a smog score and a global warming score. The label makes it easy for car buyers to compare vehicles for environmental impacts.

After the students have completed their answers to the questions on the bottom of page 7, conduct a discussion of responses to question 3 (What are three or more reasons a buyer of a new vehicle would want a high EP score?). See Answer Key in Appendix A for responses.

Part 2: Global Connections

Read page 8 on The Greenhouse Effect. Ask your students to describe in their own words how the greenhouse effect works. Students can visit the Environmental Protection Agency (EPA) website referenced on page 8 to learn more about the greenhouse effect and then answer the fill-in question.

Instruct students to read the first three paragraphs of page 9 on the Earth and Its Atmosphere Experiment. Review the “Materials Needed” and “Directions for the Experiments” information. The materials should be set up in a convenient location before the beginning of class.

Conduct the greenhouse experiment on page 9. Upon completion, discuss the findings resulting from the experiment. The water “trapped” in the plastic bag should be warmer.

Encourage students to visit www.epa.gov/climatechange/kids to learn more about the greenhouse gas effect. Remind students
that the greenhouse gas occurs naturally and without it life on Earth could not continue.

7 Introduce the pie chart activities on pages 10 and 11 (Where Do They All Come From?). These activities focus on the overall sources of greenhouse gas emissions in the United States and the energy used by specific types of transportation. Students interpret the two charts and answer questions. See Answer Key in the Appendix. This activity could be extended by having students develop their own ways of presenting this data on greenhouse gas emissions in the United States and/or the information on energy used by various types of transportation.

8 Introduce the reading Making Global Connections on page 12 and the research activities listed on page 13. The reading on page 12 provides an opportunity to review what students have been learning about greenhouse gases (GHG), climate change, and global warming in this study. The Learning More research activities could be developed as homework projects and/or as a large group activity that focuses on skills needed to effectively use the Internet to research topics.

9 Introduce the reading on page 14, Thinking Outside the Car, by having students work in small groups to brainstorm all the ways people get from one place to another. Encourage them to think in past historical times as well as the present day. Discuss the importance of thinking outside the private vehicle as a way to have cleaner air and fewer greenhouse gas emissions sent into the atmosphere.

Ask students to suggest their own energy-saving options to add to those suggested in this reading.

Have students create slogans they would suggest for a clean air campaign. On page 15 (Write Your Own Clean Air Campaign) there are some examples of slogans that have been written to encourage protection of the environment.
The Road Forward — Extending the Learning

Field Trip
Plan a class field trip to an actual greenhouse or indoor arboretum. Students can take field notes on their visit and discuss how this visit demonstrated the greenhouse effect.

Energy Patrol
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

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).
LESSON 2

Cleaner and Greener Vehicles

“If we worked on the assumption that what is accepted as true really is true, then there would be little hope to advance.”

— Orville Wright (1871–1948) American Inventor

Lesson at a Glance

In this lesson students engage in critical thinking and research activities related to vehicles powered by alternative fuels. As they analyze the pros and cons of various vehicle fuels they discover how innovations and technologies are providing a cleaner and greener way to get from one place to another.

Teacher Background

Students should have information provided them about the U.S. and world dependence on fossil fuels, especially oil, for transportation and energy needs. Activities in Lesson One demonstrated the negatives impacts of burning fossil fuels on air quality, the earth’s atmosphere, and climate change.

This lesson focuses on motor vehicles that use fuels derived solely or in part from resources other than petroleum. Some fuels covered in this study are commonly known; others, like natural gas, hydrogen, and biodiesel, will be new to students.

Staying Informed

There is a rapidly changing “roadway” when it comes to alternative fuels and alternative fueled vehicles. Students should always be encouraged to update information during this present study. The U.S. Department of Energy Alternative Fuels and Advanced Vehicle Data Center (www.afdc.gov) is a helpful website for obtaining the latest information.

Student Objectives

- Students integrate print and digital information and a diagram to explain the hydrogen fuel cell.
- Students discuss definitions and utilize the glossary to define alternative fuel (AF) and alternative fueled vehicles (AFVs).
- Students utilize informational text and charts to write about and discuss the pros and cons of alternative fuels (AFs) and alternative fueled vehicles (AFVs).
- Students research and present group projects on alternative fuels (AFs) and alternative fueled vehicles (AFVs), using domain-specific vocabulary from this study.

Materials

Provided:


Needed:

- Pictures, photos, and brochures of alternative fueled vehicles

Time Needed

Two class periods
Students are offered a range of Wheel Works projects to complete in small groups. They include creating a Word Wall with all the acronyms related to vehicle technologies, using media arts to explain a fuel cell, or researching the nearest electric vehicle charging stations.

**Students as the Experts**

There are five alternative fuels that students will learn about in this lesson. The activities on these fuels can be completed by individual students and/or students can work in groups and become the “experts” on a specific type of alternative fueled vehicle. Each group would present their findings (using visuals) to the entire class.

For further discovery, The Road Forward extension activities at the end of this lesson will expand the learning and discoveries about alternative fuels and alternative fueled vehicles.
**Vocabulary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>alternative fuel (AF)</td>
<td>A fuel taken from a resource other than petroleum. An AF produces less pollution than gasoline or diesel fuel.</td>
</tr>
<tr>
<td>alternative fuel vehicle (AFV)</td>
<td>A motor vehicle that uses only alternative fuel or a combination of an AF and gasoline of diesel fuel.</td>
</tr>
<tr>
<td>battery</td>
<td>A device that stores energy and produces an electric current.</td>
</tr>
<tr>
<td>biodiesel</td>
<td>Transportation fuel for use in diesel engines that is made from plant oils or animal fats.</td>
</tr>
<tr>
<td>charging station</td>
<td>A place where electric vehicles have their batteries charged.</td>
</tr>
<tr>
<td>diesel fuel</td>
<td>A petroleum-based fuel used in diesel engines.</td>
</tr>
<tr>
<td>electricity</td>
<td>A form of energy that is used for lighting, heating and powering forms of transportation.</td>
</tr>
<tr>
<td>electric vehicle (EV)</td>
<td>Any motor vehicle that is powered by electricity. This includes all electric vehicles, hybrid electric vehicles and plug-in electric vehicles.</td>
</tr>
<tr>
<td>ethanol</td>
<td>A carbon-based liquid fuel that can be used as an alternative fuel in vehicles.</td>
</tr>
<tr>
<td>flexible fuel vehicle (FFV)</td>
<td>A vehicle that can operate on gasoline, or blends of gasoline and ethanol.</td>
</tr>
<tr>
<td>gasoline</td>
<td>A volatile, flammable liquid made from a refined form of crude oil. Gasoline is currently the most common fuel used in vehicles.</td>
</tr>
<tr>
<td>hybrid electric vehicle</td>
<td>A vehicle that has both an electric motor and a small internal combustion engine.</td>
</tr>
<tr>
<td>natural gas</td>
<td>An air-like substance found in the earth that can be burned for heat of fuel.</td>
</tr>
<tr>
<td>natural gas vehicle (NGV)</td>
<td>A vehicle fueled by natural gas.</td>
</tr>
<tr>
<td>range</td>
<td>(As used in this study) The distance an electric vehicle can travel before the batteries need to be recharged.</td>
</tr>
<tr>
<td>zero emission vehicle (ZEV)</td>
<td>A motor vehicle that emits no pollution from its tailpipe.</td>
</tr>
</tbody>
</table>
Procedures

1. Open the lesson by posting and/or passing among the student a number of photos, pictures, articles, or brochures which illustrate some of the alternative fueled vehicles that are on the road today. Include pictures of busses and trucks that are running on fuels other than gasoline or diesel. Discuss what things they can discover from these materials. Ask students to list several things they want to know about these vehicles.

2. Introduce the section of the activity book that opens with Cleaner and Greener Vehicles. Have students read page 16 and ask them by reading and looking at the cars what would they expect to learn in this lesson. Discuss the definitions of an alternative fuel (AF) and an alternative fuel vehicle (AFV). Refer them to the Key Words glossary at the back of their book, read the definitions and ask them to tell another student how they would explain the difference between an AF and an AFV.

3. Have students turn to page 17 in their student activity guide. Ask students to think about some acronyms they frequently use. Ask why they think acronyms are used so much in scientific and technical terminology.

Answers might include that an acronym expresses a concept more quickly and efficiently than using a long string of words, and they are useful when used repeatedly in a single conversation or in print. Describe how many educators and even politicians just refer to STEM rather than science, technology, engineering, and mathematics. So far in this study students have seen GHG (greenhouse gas) a number of times and in this lesson will become familiar with a myriad of new acronyms.

4. Review the five Wheel Works projects on page 17. These small group activities described here can be conducted either in class or assigned as homework. Ask students what they would need to complete these group activities (e.g. time to meet with group, Internet access, a bulletin board, art supplies, magazine photos, etc.).

Wheel Works projects can be presented to the entire class at the end of this lesson or as a culminating activity at the end of the unit.
Skim pages 18 through 27 with students so they have an idea how this section is organized and what is expected of them. There are overviews of vehicles powered by electricity, natural gas, hydrogen, biodiesel, and ethanol. Explain that after each reading they are to identify the pros and cons of each alternative fuel. Throughout this section students are provided additional websites if they want to do further research.

**Note:** Teachers might want to organize the students into five small groups and assign them to become the class experts on one vehicle or fuel topic (e.g., electric vehicles or vehicles fueled with natural gas). They would be responsible for presenting their findings to the entire class.

Summarize this lesson at the conclusion of the student reports. Reviewing the pros and cons of the various alternative fuels and alternative fuel vehicles is one way to do this. See Answer Key in the Appendix for sample pro and con responses and for additional points that can be used when summarizing the information.

Review that developing alternative vehicle fuels from resources other than petroleum is an ongoing process. At this time, people can only speculate on which fuels will eventually replace gasoline and diesel as the primary fuels for motor vehicles. Ask students to give their opinions on whether they see a future in which “Zero Emissions Vehicle” are as common as the gasoline- or diesel-powered vehicle is today.

Stress that replacing today’s motor vehicles with vehicles powered by alternative (non-petroleum) fuels would greatly reduce air pollution, and greenhouse gases that contribute to global climate change.
The Road Forward — Extending the Learning

✦ **Green Vehicle Guide**
Visit the Environmental Protection Agency (EPA) green vehicle guide at [www.epa.gov/greenvehicles/index.do](http://www.epa.gov/greenvehicles/index.do) and use the interactive menus to select three hybrid car models to compare their fuel efficiencies. Make a hard copy of findings and report to the class.

✦ **LPG — An Alternative Fuel Source**
Research the characteristics and uses of propane (liquefied petroleum gas or LPG) as an alternative fuel source. Why do many delivery trucks, taxis, and buses use LPG? See [www.afdc.energy.gov/afdc/vehicles/propane_what_is.html](http://www.afdc.energy.gov/afdc/vehicles/propane_what_is.html)

✦ **Clean School Bus USA**
Research the Clean School Bus USA program at [www.epa.gov/cleanschoolbus](http://www.epa.gov/cleanschoolbus). Students should report on the site and provide facts that include data on children and youth using school buses daily. As a follow-up, students could interview school officials to determine whether any diesel school buses in use are being retrofitted or replaced.

✦ **Renewables and Distributed Generation**
Students can research how businesses and homes are generating their own electricity using renewable energy sources like solar and wind. As part of their research they should identify examples of distributed energy generation in their own city or geographic region.
Lesson at a Glance

A reading on the Power of the Imagination connects students with the idea that over time people have imagined many things that were beyond the available technology. Students let their own imaginations fly as they complete an “Imagineering” exercise. They take on energy-saving action projects, explore some green jobs, and do further research on topics they select. Key ideas will be reviewed as they complete a crossword puzzle.

Teacher Background

“Extending the Journey” focuses students on taking action by applying what they have learned in this study and learning more from the suggested enrichment activities. A reading on the Power of the Imagination introduces or reintroduces students to the ideas of Leonardo da Vinci, who lived in the 15th and 16th centuries, and Jules Verne (1828–1905). Both men imagined things that were at the time beyond possibility. Students will form their own “Imagineering” teams to envision a future world of transportation.

Actions for the Environment

Students can select a transportation school project to reduce the amount of fuel that is used getting to and from school. They can also consider projects such as no-idling zones around the school or a walking school bus. They can take other energy-saving actions in their own classroom and school building like turning off lights and computers when not needed.
Students view a Green Jobs Board and are introduced to the idea of green jobs and careers. They analyze four posted jobs and determine what makes these jobs green. Additional research activities in Take the Internet Highway provide an opportunity for students to select a topic that interests them most.

**Vocabulary**

**carpool**
A plan where two or more people travel to and from work, school, or other activities in one automobile.

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

**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.

**idling**
When an engine is running but the vehicle is stopped. Idling gets zero miles per gallon.

**imagineering**
A blended word formed from imagination and engineering.

**ridesharing**
An alternative to traveling alone such as carpooling, vanpooling, or using public transit.

**transit**
Buses, light rail, trains, and subways used by the public. Also referred to as public transit or public transportation.

**trip chaining**
Combining car trips by doing a number of errands on a single trip.

**vanpool**
A vehicle used on a regular basis to carry a group off to a certain destination, such as an office or college campus. See carpool.
## Procedures

1. Introduce *The Power of the Imagination* (page 28) by asking students to think awhile about books, movies, or videos they have seen with devices and machines that do not yet exist. (Students might be familiar with or have read science fiction books.)

2. Explain that Leonardo da Vinci and Jules Verne were two men who imagined and even drafted plans for things that did not come about for many years. Leonardo da Vinci, living in the 15th and 16th centuries, imagined such things as diving bells and flying machines. None were produced until 400 years after his death. Refer students to the drawing of his flying machine.

3. Have students read page 28 and be prepared to discuss:
   - How do inventions usually begin?
   - Why are some inventions considered “revolutionary”?
   - What are the transportation developments mentioned in this reading?
   - What does the U.S. transportation system contribute to global climate change?
   - How would you explain in your own words the last paragraph (Cleaner Transportation) on page 28?

4. Organize students into groups to form Imagineering teams to complete the activity on page 29 (Imagineering). Their topics should relate to cleaner and less-polluting transportation choices for the future. Students should be reminded that transportation is the way that people move from one place to another and does not just mean vehicles, as we know them. Some students might think in terms of a city where there are no automobiles, but other devices to move people.

5. Organize students into small groups to develop some cleaner transportation projects they can conduct at the school. After student have read page 30 (*Actions for the Environment*), discuss the purpose of these projects. This includes:
   - reducing fuel consumption
   - conserving natural resources
   - improving air quality
   - decreasing the amount of pollutants in the air

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**Power Point!**

Sometimes the imagination is far ahead of the technology to make it happen.
As school settings are so varied teachers will need to discuss the type of activities that would be appropriate and doable for their class or school. Page 31 (Cleaner Transportation Projects) offers a range of suggestions for these projects.

**Note:** Teachers will want to involve other classes in these clean transportation projects. For example, a no-idling zone at the school would involve all the parents or guardians who drop off and pick up children, as well as school bus drivers.

6 Introduce the Think Green activity by first asking students what they think about when they hear or read the word green. They should understand after reading page 32 that today the word “green” is much more than a color.

Have students look at the positions on the Green Jobs Board and describe what makes these jobs “green.” As a final activity on page 33 they should write a description of a green job that would interest them in the future.

7 Discuss the research activity, Take the Internet Highway: Making More Connections. Explain that this research should be based on topics studied in this unit that personally interest them. Some students might need help in selecting a topic and some ideas are listed on page 34. There are six websites also listed on this page where they can begin their research.

Provide time for students to present their research to the entire class.

8 Have students turn to the Crossword Puzzle activity on pages 36–37. This activity can be used to help assess student learning and if so students should not use the glossary (Key Words) or other parts of the book. Teachers might want to make this just an open book activity.

Review the answers with the class. (See Answer Key in the Appendix.)
9 Distribute a Go Global poster to each student. Review the content on the poster and stress some of the important actions they and their family members can take for the environment. This poster along with the activity books should go home with the students. The poster (both sides) could be posted in the classroom to remind them of this study.

10 Summarize this lesson and the entire unit by asking each student to write a few sentences about what they remember most from this study. Ask students to return to the introduction on page 1 (Why?) to determine if the question why study about transportation, energy, and the environment has been answered for them.

The Road Forward — Extending the Learning

- **Green Is More Than a Color**
  Students can complete the three activities from the *Transportation, Energy, and the Environment Career Supplement* (found in Appendix B). These activities related to green careers and jobs can enhance what students have already learned about work in renewable energy fields in this unit of study.

- **Our Energy Choices**
  [www.eere.energy.gov/kids](http://www.eere.energy.gov/kids)
  Students will discover at this government website the importance of making wise energy-saving choices. As they play interactive games, complete puzzles, and encounter energy “monkeys,” they will learn the importance of saving energy, conserving natural resources, and protecting the environment.

- **What Time Is It? Shifting Our Demand for Energy**
  Students should research and analyze why the demand for energy peaks during certain hours of the day. They might begin by asking their parents or guardians why they think there are peak demand times for energy.

  Students should report their findings to the class including how peak demand impacts the utilities that are providing the energy. Conduct a class discussion on actions individuals, businesses, schools, and governmental agencies could take to shift their demand for energy to non-peak times.
Lesson 1: Getting Around

Page 3, Getting from Here to There chart
Responses will vary from student to student.

Page 7, Air Quality and Pollution
Student answer will vary, but should cover the points below.
1. What is the smog score?
   Answer: Vehicles are given a score on the amount of smog forming emissions when they are operating. The higher the score the cleaner the vehicle drives.
2. What is the global warming score?
   Answer: This score is based on greenhouse gas (GHG) emissions from both the vehicle when it is operating and also from fuel production.
3. What are three or more reason a buyer of a new vehicle would want a high EP score?
   Answers will vary by student (e.g., cleaner air, fewer pollutants, good for the environment).

Page 10, Where Do They All Come From? (Interpreting a Pie Chart)
1. The data on the chart is divided into five sections. The combined sections will add up to 100%.
2. Electricity production accounts for 33% of all the greenhouse gas emissions.
3. The second-largest contributor to greenhouse gas emission is transportation. This sector contributes 27% of all the greenhouse gas emissions.

Page 11, Interpreting a Pie Chart
1. Buses and trains use 3% of all energy used for transportation.
2. In the United States 9% of all the energy used for transportation is used for aircraft.
3. The data indicates that cars, motorcycles and all types of trucks use 77% of the energy used for transportation. Note: Students need to add the 59% used (by light trucks, cars and motorcycles) to the 18% used by other trucks.
Lesson 2: Cleaner and Greener Vehicles

Page 19, Electric Vehicles

Review the material to ensure that students understand the key points:

» EVs are all-electric vehicles powered by battery packs.
» They are recharged by plugging into a power source.
» HEVs are hybrid electric vehicles that use a combination of a battery pack and gasoline engine; the gasoline engine recharges HEVs
» PHEVs are plug-in hybrid electric vehicles that can be recharged at an electric outlets
» Only EVs produce no exhaust or emissions.

Suggested website for more information: www.afdc.energy.gov/afdc/vehicles/electric.html

Note: The pros and cons listed are illustrative of how students might respond. Students might consider only the purchase price of a vehicle and not the saving in fuel costs over a time period.

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>PROS</th>
<th>CONS</th>
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</thead>
<tbody>
<tr>
<td>EVs</td>
<td>zero emissions</td>
<td>short driving range; more expensive than conventional vehicles</td>
</tr>
<tr>
<td>HEVs</td>
<td>high fuel economy; low emissions</td>
<td>short driving range; more expensive than conventional vehicles</td>
</tr>
<tr>
<td>PHEVs</td>
<td>less petroleum consumption; gasoline not required if driven short distances only</td>
<td>short driving range; more expensive than conventional vehicles</td>
</tr>
</tbody>
</table>

Page 21, Natural Gas Vehicles

Students should note that despite the benefits of natural gas vehicles, few are on the market today.

Pros and cons of using natural gas as a vehicle fuel:

» Some pros: less toxic and fewer greenhouse emissions; lower fuel cost
» Some cons: natural gas vehicles are more expensive than gasoline and diesel powered vehicles; shorter driving range than conventional vehicles

Another clean burning gas is propane (liquefied petroleum gas or LPG). Many commercial motor vehicles have been converted to use propane instead of gasoline.

Page 23, Hydrogen Vehicles

To answer the questions on page 23, students can be referred to the U.S. Energy Information Administration’s Energy Kids website: www.eia.gov/kids/energy.cfm?page=hydrogen

1 Nine million metric tons
2 NASA is the National Aeronautics and Space Administration. NASA uses hydrogen as an energy fuel
3 Automobiles and buses
4 Answers will vary.

Note: According to the Department of Energy, hydrogen “has the potential to revolutionize transportation and, possibly, our entire energy system,” The development of hydrogen-power is in its very earliest stages. See: www.afdc.energy.gov/afdc/fuels/hydrogen.html
According to the U.S. Energy Information Administration (EIA) in 2011, there are currently more than 300 hydrogen-fueled vehicles in the U.S. Most of these vehicles are buses and automobiles powered by electric motors. They store hydrogen gas or liquid on board and convert the hydrogen into electricity for the motor using a fuel cell. Only a few of these vehicles burn the hydrogen directly (e.g., producing almost no pollution).

Pages 24, Biodiesel Vehicles

Pros and cons of using biodiesel as a vehicle fuel: [www.fueleconomy.gov/feg/biodiesel.shtml](http://www.fueleconomy.gov/feg/biodiesel.shtml) for a concise explanation of the pro and cons of biodiesel fuel.

- Some pros: renewable; less polluting; non-toxic
- Some cons: more expensive; less fuel economy; short driving range; more expensive than conventional vehicles

**Note:** Ask students to explain why the short driving range (the distance a vehicle can travel before running out of fuel) creates “driving range anxiety” among many potential electric car purchasers. (Answers: EV owners worry that on the road they will run out of power before being able to recharge the battery. Drivers of cars using biodiesel might wonder where stations are located where they can find the correct fuel.)

Page 27, Ethanol Vehicles

Student answers on ethanol vehicles will vary as to what they already know, what they want to know and what they have learned. Teachers will want to review their KWH charts as to what they have learned as a result of their reading and research.

**Note:** Ethanol is usually made from corn in this country. Blended with gasoline it has a long history and is in wide use today. Many vehicles in use today are flexible fuel vehicles capable of running on either gasoline or a blend of up to 85 percent ethanol. Further information is found at: [www.fueleconomy.gov/feg/flextech.shtml](http://www.fueleconomy.gov/feg/flextech.shtml)

Lesson 3: Extending the Journey

Page 32, Think Green

Student answers will vary but should reflect and understand that green jobs or careers benefit the environment and also conserve natural resources.

**Note:** There are many definitions of green jobs. The following is how the U.S. Department of Labor, Bureau of Labor Statistics, defines green jobs:

- “Green jobs are either jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources. (or)"
- “Jobs in which workers’ duties involve making their establishment’s production processes more environmentally friendly or use fewer natural resources.” [www.bls.gov/green](http://www.bls.gov/green)

Page 36, Crossword Puzzle

See solution on next page.
Crossword Puzzle Solution
# Common Core State Standards (CCSS)*

## Transportation, Energy, and the Environment Correlations for Grade 6

### Common Core State Standards

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### ACTIVITIES

#### Language Standards (LS) Vocabulary Acquisition & Use

**6.LS.4c.** Consult reference materials, both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.

**Students:**
- write, discuss and research key ideas from "Fueling Our Journeys" text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- discuss definitions and utilize the glossary to define alternative fuel (AV) and alternative fueled vehicles (AFV).
- consult the glossary and informational text to solve a crossword puzzle that utilizes domain-specific vocabulary.

#### Reading Standards for Literacy in Science/Technical Subjects (RST) Craft and Structure

**6-8.RST.4.** 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.

**Students:**
- integrate smog data presented in Environmental Performance labels with print and digital texts.
- discuss definitions and utilize the glossary to define alternative fuel (AV) and alternative fueled vehicles (AFV).
- consult the glossary and informational text to solve a crossword puzzle that utilizes domain-specific vocabulary.

#### Reading Standards for Literacy in History/Social Studies (RH) Integration of Knowledge & Ideas

**6-8.RH.7.** Integrate visual information with other information in print and digital texts.

**Students:**
- integrate smog data presented in Environmental Performance labels with print and digital texts.
- integrate greenhouse gas emissions and transportation data in pie charts with print and digital texts to analyze sources of greenhouse gas emissions.
- integrate print and digital information with diagram in order to learn about the hydrogen fuel cell.
- utilize informational text and charts to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).
- read informational text to write and explain what makes a job “green.”
- discuss, develop, and research clean transportation projects for the school.
- utilize web-based digital resources to research topics related to this study of transportation, energy, and the environment.

* 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)
### Common Core State Standards (continued)

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<td><strong>Lesson One</strong></td>
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<td><strong>Getting Around</strong></td>
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</table>

#### Reading Standards for Informational Text (RST) Range of Reading and Level of Text Complexity

**6.RST.10.** By the end of year, read and comprehend informational texts.

**Students:**
- integrate greenhouse gas emissions and transportation data in pie charts with print and digital texts to analyze sources of greenhouse gas emissions.
- write, discuss and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)

**Students:**
- integrate print and digital information with diagram in order to learn about the hydrogen fuel cell.
- utilize informational text and charts to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).

**Students:**
- discuss key ideas of the Power of the Imagination reading, such as impacts of inventions on society and global climate change.
- utilize web-based resources to research topics related to this study of transportation, energy, and the environment.

#### Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (WHST) Research to Build and Present Knowledge

**6-8.WHST.7.** Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

**Students:**
- write, discuss and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- conduct a scientific experiment with their teacher to write and explain how the greenhouse effect is created.
- utilize and list web-based resources to research topics about climate change and global warming.

**Students:**
- create and present group projects on alternative fuels (AF), alternative fueled vehicles (AFV) or domain-specific vocabulary used in this study.

**Students:**
- discuss, develop, and research clean transportation projects for the school.
- utilize web-based resources to research topics related to this study of transportation, energy, and the environment.

**6-8.WHST.9.** Draw evidence from informational texts to support analysis, reflection, and research.

**Students:**
- write, discuss and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- utilize and list web-based resources to research topics about climate change and global warming.
- integrate greenhouse gas emissions and transportation data in pie charts with print and digital texts to analyze sources of greenhouse gas emissions.

**Students:**
- create and present group projects on alternative fuels (AF), alternative fueled vehicles (AFV) or domain-specific vocabulary used in this study.
- utilize informational text and charts to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).

**Students:**
- discuss, develop, and research clean transportation projects for the school.
- utilize web-based resources to research topics related to this study of transportation, energy, and the environment.
- write and summarize what they have learned about transportation, energy, and the environment from the activity book and Go Global poster.
### Common Core State Standards

#### Lesson One
Getting Around

#### Lesson Two
Cleaner and Greener Vehicles

#### Lesson Three
Extending the Journey

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<th>ACTIVITIES</th>
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#### Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (WHST) Range of Writing

**6-8.WHST.10.** Write routinely over extended time frames and shorter time frames for a range of discipline-specific tasks, purposes, and audiences.

**Students:**
- Write, discuss, and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- Conduct a scientific experiment with their teacher to write and explain how the greenhouse effect is created.

**Students:**
- Create and present group projects on alternative fuels (AF), alternative fueled vehicles (AFV) or domain-specific vocabulary used in this study.
- Utilize informational text and charts to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).

**Students:**
- Discuss, develop, and research clean transportation projects for the school.
- Read informational text to write and explain what makes a job “green.”
- Write and summarize what they have learned about transportation, energy, and the environment from the activity book and Go Global poster.

#### Speaking and Listening (SL) Comprehension and Collaboration

**6.SL.1d.** Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing.

**Students:**
- Write, discuss, and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- Review and discuss what they have learned about greenhouse gases, climate change, and global warming.

**Students:**
- Create and present group projects on alternative fuels (AF), alternative fueled vehicles (AFV) or domain-specific vocabulary used in this study.
- Utilize informational text and charts to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).

**Students:**
- Discuss key ideas of the Power of the Imagination reading, such as impacts of inventions on society and global climate change.
- Discuss, develop, and research clean transportation projects for the school.
# Next Generation Science Standards (NGSS)*
## Transportation, Energy, and the Environment Correlations for Grade 6

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<th>Next Generation Science Standards</th>
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<th>Lesson Two Cleaner and Greener Vehicles</th>
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<tr>
<td><strong>Crosscutting Concepts</strong></td>
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<tr>
<td>Ecosystems: Interactions, Energy, and Dynamics</td>
<td>Students: integrate smog data presented in Environmental Performance labels with print and digital texts.</td>
<td>Students: create and present group projects on alternative fuels (AF), alternative fueled vehicles (AFV) and research the various technologies related to these vehicles.</td>
<td>Students: write and summarize what they have learned about transportation, vehicle technologies, and the environment from the activity book and Go Global poster.</td>
</tr>
<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>Students: discuss how various technologies are used to measure pollutants and air quality.</td>
<td>Students: utilize informational text to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).</td>
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<tr>
<td><strong>Disciplinary Core Ideas</strong></td>
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<tr>
<td>Earth and Human Activity</td>
<td></td>
<td></td>
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<tr>
<td>ESS3.C: Human Impacts on Earth Systems</td>
<td>Students: discuss smog data presented in Environmental Performance labels and print and digital texts.</td>
<td>Students: present group projects on alternative fuels (AF) and alternative fueled vehicles (AFV), and analyze their environmental impacts.</td>
<td>Students: discuss key ideas in the Power of the Imagination reading and discuss how some inventions can have both positive and negative impacts.</td>
</tr>
<tr>
<td>MS-ESS3-3. Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.</td>
<td>Students: integrate greenhouse gas emissions and transportation data to analyze the effects on living things.</td>
<td>Students: write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).</td>
<td>Students: utilize web-based resources to research topics and discuss the different environmental impacts of our transportation choices.</td>
</tr>
</tbody>
</table>
### Disciplinary Core Ideas

#### MS. Earth and Human Activity
- **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.

#### MS. Engineering Design
- **ETS1.B: Developing Possible Solutions**
  - MS-ETS1-2 & 3. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

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<td><strong>Cleaner and Greener Vehicles</strong></td>
<td><strong>Extending the Journey</strong></td>
</tr>
</tbody>
</table>

**ACTIVITIES**

**Students:**
- write, discuss and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts of using fossil fuels for transportation energy.)
- utilize web-based resources to research topics about climate change and global warming.
- analyze smog data presented in Environmental Performance labels with print and digital texts.
- relate information on greenhouse gas emissions and transportation to climate.

**Students:**
- integrate print and digital information in order to learn about electric vehicles and other vehicle technologies.
- create and present group projects on alternative fuels (AF) and alternative fueled vehicles (AFV).
- utilize informational text to write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV), and discuss how they reduce greenhouse gas emissions.

**Students:**
- read transportation-related informational text to write and explain what makes a job “green.”
- discuss, develop, and research clean transportation projects for the school (e.g., cleaner air).
- write and summarize what they have learned about transportation, energy, and the environment from the activity book and Go Global poster.

**Students:**
- research the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).
- discuss how AF and AFV vehicles are providing one solution to global climate change.
## Crosscutting Concepts (Influence of Science, Engineering, and Technology on Society and the Natural World)

### MS. Engineering Design

<table>
<thead>
<tr>
<th>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 natural environment.</th>
<th>Students:</th>
<th>Students:</th>
<th>Students:</th>
</tr>
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<tbody>
<tr>
<td>- write, discuss and research key ideas from “Fueling Our Journeys” text (e.g., environmental impacts and consequences of using fossil fuels for transportation energy.)&lt;br&gt;- utilize web-based resources to research short- and long-term consequences of increased greenhouse gas (GHG) emissions on climate change.&lt;br&gt;- integrate smog data presented in Environmental Performance labels with print and digital texts.&lt;br&gt;- integrate greenhouse gas emissions and transportation data to analyze effects on people and the natural environment.</td>
<td>- create and present group projects on alternative fuels (AF) and alternative fueled vehicles (AFV) and relate to impacts on environment.&lt;br&gt;- write and discuss the pros and cons of alternative fuels (AF) and alternative fueled vehicles (AFV).</td>
<td>- discuss, develop, and research clean transportation projects for the school (e.g., no idling zones),&lt;br&gt;- utilize web-based resources to research topics related to transportation, clean air, and health.&lt;br&gt;- write and summarize what they have learned about transportation, energy, and the environment from the activity book and Go Global poster. Discuss various modes of transportation.</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 Pre-Kindergarten–Middle School

Pacific Gas and Electric Company’s Energenius Educational Series provides engaging, educational programs that teach pre-K, elementary, and middle school students about energy and its wise use. 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 Content Standards.
- 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

**alternative fuel (AF)**
A fuel taken from a resource other than petroleum. An AF produces less pollution than gasoline or diesel fuel.

**alternative fuel vehicle (AFV)**
A motor vehicle that uses only alternative fuel or a combination of an AF and gasoline of diesel fuel.

**battery**
A device that stores energy and produces an electric current.

**biodiesel**
Transportation fuel for use in diesel engines that is made from plant oils or animal fats.

**carpool**
A plan where two or more people travel to and from work, school, or other activities in one automobile.

**charging station**
A place where electric vehicles have their batteries charged.

**climate change**
Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer).

**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**
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.

**diesel fuel**
A petroleum-based fuel used in diesel engines.

**electricity**
A form of energy that is used for lighting, heating and powering forms of transportation.

**electric vehicle (EV)**
Any motor vehicle that is powered by electricity. This includes all electric vehicles, hybrid electric vehicles and plug-in electric vehicles.

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

**ethanol**
A carbon-based liquid fuel that can be used as an alternative fuel in vehicles.

**flexible fuel vehicle (FFV)**
A vehicle that can operate on gasoline, or blends of gasoline and ethanol.

**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.

**gasoline**
A volatile, flammable liquid made from a refined form of crude oil. Gasoline is currently the most common fuel used in vehicles.

**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 greenhouse gases from human activities.
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]

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

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

hybrid electric vehicle
A vehicle that has both an electric motor and a small internal combustion engine.

idling
When an engine is running but the vehicle is stopped. Idling gets zero miles per gallon

imagineering
A blended word formed from imagination and engineering.

internal combustion engine
A device in which the fuel is ignited and burned within a combustion chamber, producing mechanical energy.

natural gas
An air-like substance found in the earth that can be burned for heat of fuel.

natural gas vehicle (NGV)
A vehicle fueled by natural gas.

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

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
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.

range
(As used in this study) The distance an electric vehicle can travel before the batteries need to be recharged.

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

ridesharing
An alternative to traveling alone such as carpooling, vanpooling, or using public transit.

smog
A form of air pollution visible in the air as a brownish-yellow haze. Smog is caused by a buildup of either ground-level ozone or tiny particles of soot known as particulate matter (PM). Smog can form almost anywhere large amounts of air pollution are released.

transit
Buses, light rail, trains, and subways used by the public. Also referred to as public transit or public transportation.

trip chaining
Combining car trips by doing a number of errands on a single trip.
vanpool
A vehicle used on a regular basis to carry a group off to a certain destination, such as an office or college campus. See carpool.

zero emission vehicle (ZEV)
A motor vehicle that emits no pollution from its tailpipe.
Career Awareness – Across the Grades
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 these jobs and careers. Career awareness activities help students make connections between what they study in school and a future world of work.

Exploration
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.

Green Jobs
As part of this Energenius program, students were introduced to jobs in the Think Green activity. These included a wind power technician and an installer of electric vehicle (EV) charging stations. However, many green jobs are created as workers in existing occupations gain new skills. Examples in the transportation sector are mechanics trained on petroleum-fueled vehicles that are being re-trained to work on hybrid and electric vehicles. Although green jobs exist in every sector of the economy, the three activities in this supplement will focus on transportation, energy, and the environment.

Greening of Occupations
What are new green jobs? A turbine technician at a wind farm or an installer of electric vehicle (EV) charging stations are just two examples. Many new jobs in the transportation sector require workers to gain the training and skills needed to work “green.”

ACTIVITY ONE:
Let’s Go with Green Transportation.....2-3

ACTIVITY TWO:
Revving Up for Action ......................... 4-5

ACTIVITY THREE:
Going Green News ................................. 6

The above activities can be easily copied for individual student use.
Green Vehicles
Wouldn’t Henry Ford (1863-1947) and Enzo Ferrari (1898-1988) be surprised to hear that “green vehicles” mean something more than the color they are painted? Both these men founded automobile companies, over a century ago, that are still producing cars that bear their names. Ford and Ferrari probably never imagined that the word green would mean much more than a color. However, today green is now used to describe numerous products or services that improve the quality of the environment and reduce energy consumption. A green car pollutes less, keeps the air clean, and reduces greenhouse gas (GHG) emissions that contribute to global climate change. Green vehicles make less of an impact on the environment and do not depend on nonrenewable energy sources as a source of power.

A “Green” Score
Ford and Ferrari would also probably be surprised to learn that all new autos sold in the U.S. are labeled with both a fuel economy score and an environmental score. This Environmental Protection Agency (EPA) score rates vehicles both on smog and greenhouse gas (GHG) emissions. Car buyers can now evaluate not only miles per gallon (MPG) but also the environmental impacts of a vehicle they purchase. Buyers of electric vehicles and plug-in hybrids are given an MPGe or miles per gallon equivalent score.

Jobs from Design to Sales
Much has changed over the years in the way vehicles are designed, manufactured, marketed, and sold. People who have shifted from working with internal combustion engines to electric cars have had to gain new skills. Although electric cars share many basic parts found in traditional vehicles, they have unique components like electric motors and lithium-ion batteries. Even those who work in sales of electric vehicles must become very familiar with these cars and, for example, the difference between a hybrid and a plug-in hybrid vehicle.

Directions:
1. Read the Q and A interview with a salesperson that works directly with a range of customers who are interested in buying an electric vehicle.

2. Make a list of skills that could make a vehicle salesperson most effective in his or her job.

3. Would a green job in selling electric vehicles be appealing to you? Yes or No? Why?
The Selling of Electric Vehicles

In this interview you will learn more about the job of a vehicle retail salesperson. This salesperson sells vehicles to potential customers.

**Q. What got you interested in a job selling cars?**

**A.** When I was a high school student, I always had a sales job during the summer. One year it was selling video games and another summer I sold sports equipment. For five years after high school I had a number of sales jobs. And recently I combined my interest in cars and my sales experience for the job I have now. I work in an auto showroom that features new electric vehicles.

**Q. What makes selling cars different from other sales jobs?**

**A.** Buying a car can be both an expensive and complicated matter. It is important for sales people to ensure that customers get the information they need to get the “right” car for them. Buying a car can be one of the biggest purchases many customers make. Customers also need assistance from the salesperson with the financing of a vehicle.

**Q. How do you prepare to help your customers?**

**A.** I need to be very familiar with the various models and the optional features that are available. A special on the job training program on electric vehicles has been helpful.

Many customers are not familiar with the differences in electric vehicles. Some buyers need to be informed of the basic differences between more traditional cars and electric vehicles. I am the person that “educates” customers about the advantages of these green vehicles.

**Q. What are some of the positives about your sales job?**

**A.** I really enjoy sales and working with people. I like the challenges of learning about alternative-fueled vehicles. I also like the idea that I can help customers understand the environmental advantages of electric vehicles.

**Q. What are some negatives of vehicle sales jobs?**

**A.** One of the negatives of the job can be long hours and the scheduling. Sales people have to be on the job when customers are available and that can mean nights, weekends, and holidays.

**Q. Would you call your electric vehicle sales job a green job?**

**A.** A definite yes! Electric vehicles reduce pollution and the use of fossil fuels.
ACTIVITY TWO: Revving Up for Action

Students all around the United States are taking on environmental projects at their schools and in their communities. The actions of students help reduce our use of energy and help conserve natural resources. Transportation projects like “no idling” zones around schools mean less pollution and fuel savings as well. These actions for the environment will help you learn about the “jobs” it takes to plan, implement, and conduct a project.

Select a project!  Define your job!  Rev up for action!

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.

■ Transportation Planners
Create a campaign dedicated to using less fuel to get to and from school. Select from some of these ideas that could work in your community:
- Bike safely to school
- The walking school bus
- Car-pooling for parents and their children
- Car-pooling for faculty
- Walking field trips

■ 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 of the 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 establish 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 parents dropping and picking up students, and on school bus drivers. Idling cars and buses get zero miles to the gallon and pollute the air.
**Taking Green Actions for the Environment**

**Directions:**
Complete this page after your group or class has selected a "green" project to organize and implement this school year.

1. What is your project?

__________________________________________________________________________
__________________________________________________________________________

2. Make a list of tasks (jobs) that will need to be conducted for your project. Next to each 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.

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<th>Tasks (Job)</th>
<th>Job Title</th>
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ACTIVITY THREE: Going Green News

THE GREEN GAZETTE
NEWS FOR A GREENER WORLD

Jobs and Electric Vehicles
“Electric vehicles are an important component of the growing green economy.” This is what the U.S. Bureau of Labor Statistics (BLS) wrote about electric vehicles. Because electric vehicles reduce pollutants and dependence on fossil fuels to power them they are part of this “green economy.” The BLS sees a great potential of new jobs and careers in all phases of the electric vehicle industry.

A Growing Industry
This electric vehicle industry grows as more vehicles are purchased each year. California at the end of 2014 had more electric vehicles on the road than any other state. Residents of California were driving an estimated 40 percent of all electric cars sold in the United States.

Driving Job Growth
In the electric vehicle industry workers are needed with a variety of backgrounds and skills. These backgrounds include the scientists who conduct research, vehicle designers, workers in manufacturing plants, technicians who repair the cars, and those who market and sell the vehicles. Others work in green jobs like installers of charging stations that support these vehicles once they are on the road.

Cleaner and Renewable Energy Sources
California has laws mandating that more and more renewable energy sources must be used to generate electricity. By the year 2020 the goal is that 33 percent of all electricity generated in the state must come from renewable energy sources. These sources include biomass, geothermal, hydroelectric, solar, and wind. Information on how our state is doing in meeting this goal can be found on the California Energy Commission website. (www.energy.ca.gov) California is not the only state with renewable goals for the generation of electricity. The goals vary widely by state. Information by state on renewable goals can be researched at www.eia.gov.

Transport: To get from one place to another.
Green transport is also called sustainable transport. This type of transport does not depend on nonrenewable energy sources for fuel.

Directions: Select one of the following topics to research and write an article for a classroom issue of The Green Gazette.

1. Research data for California on the breakdown of types of electric vehicles sold in the most recent year. Electric vehicles are classified as hybrids, plug-in hybrids, and all-electric vehicles.

2. Research some of the special manufacturing processes required for working on electric vehicles. These electric vehicle systems are more complex than traditional internal combustion engines. Describe some of the green jobs and electric vehicle-occupations involved in the manufacturing process of electric vehicles. Search on the U.S. Bureau of Labor Statistics (www.bls.gov) website.

3. Research the most recent data on how California is doing in reaching its 2020 goal of having 33 percent of its electricity generated from renewable energy sources. Write a renewable energy article for your class newspaper that focuses on green jobs that could result from this goal.