

## ACTIVITY 4

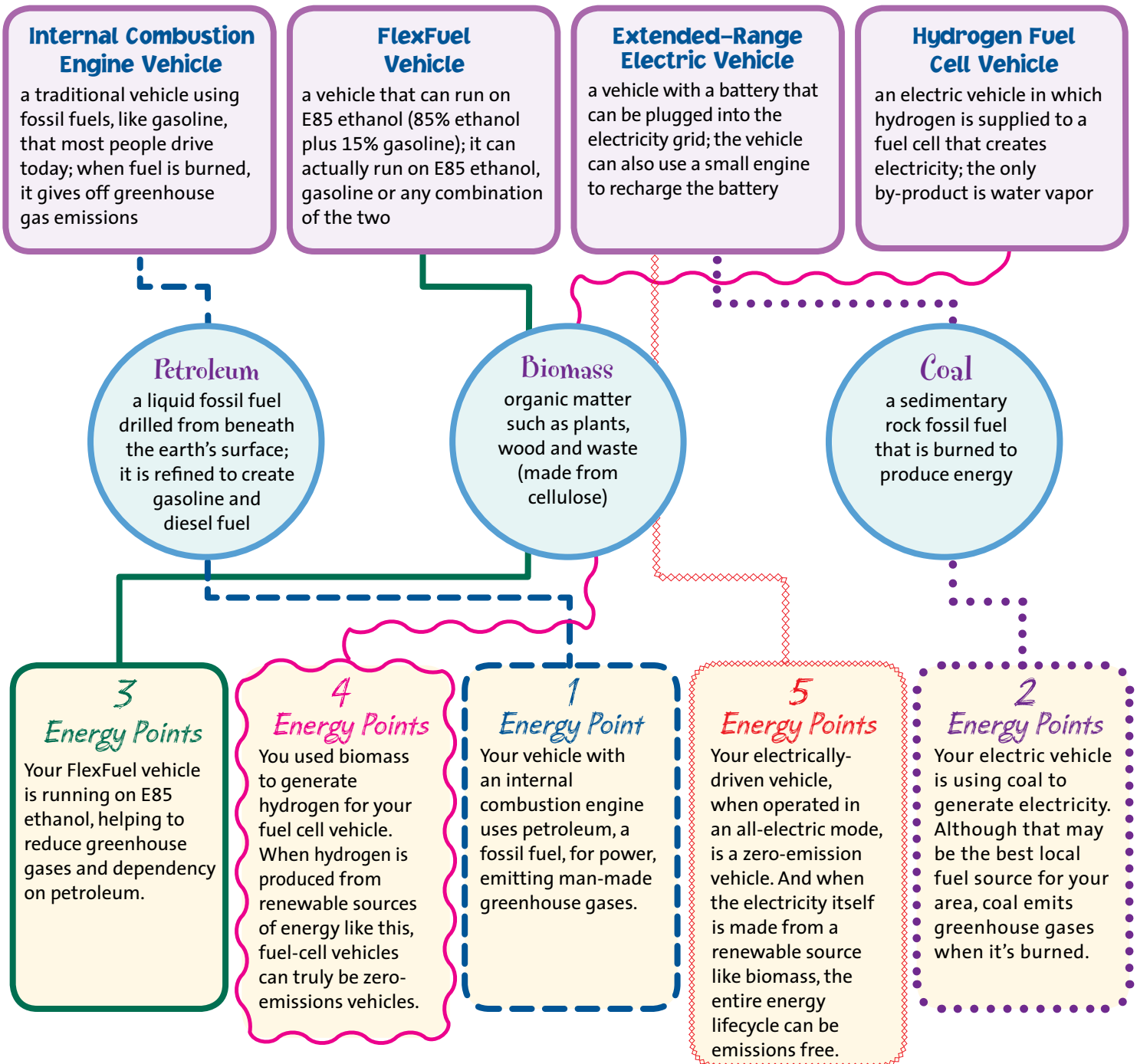
NAME \_\_\_\_\_

### Earn Points with Technology

Today, petroleum is used to power almost all automobiles. Petroleum is a fossil fuel that emits greenhouse gases, like carbon dioxide, when burned. The concentration of greenhouse gases in the atmosphere is increasing. And, energy consumption worldwide is projected to significantly increase over the next 50 years.

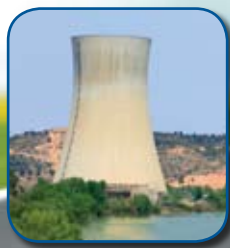
Across the globe, society needs to reduce petroleum use and greenhouse gas emissions. Advances in technology and the use of renewable energy resources are the keys to helping reduce man-made carbon dioxide emissions. Take a look at four different

vehicle technologies below, along with some fuel source options. Which combinations would result in the least amount of carbon dioxide emissions? Look for the higher Energy Points—that means that you are emitting less carbon dioxide.



# THE ENERGY HIGHWAY

*Solutions Ahead*



Energy has proven to be one of the top issues of this century as we face an increasingly uncertain energy future on a global basis.

*Use this comprehensive curriculum with your students to explore the energy challenges we are facing and the solutions that lie ahead.*

## Message to Educators

Since 2001, a series of geopolitical, natural and economic realities—from extraordinary economic growth in China and India, to regional conflicts in the Middle East, to population growth, global climate change and natural disasters in the Gulf of Mexico—have combined to drive home the fact that we need to rethink and restructure our energy framework on a global basis.

This century will be defined by our ability to discover and implement innovative

solutions to promote energy security and alternatives to petroleum-based resources, while meeting the increasing demand for energy across the globe and minimizing environmental impact.

We hope this curriculum helps you explore these issues with your students. This generation of young people holds the key to forming and advancing the solutions that will supply and sustain energy for our growing and prospering world.

## Tell Us What You Think!

Please share your thoughts on how this program was used or could be improved to help you in the classroom. You can return the enclosed evaluation form by mail or fax, or simply go to [www.wrinsiders.com/gm](http://www.wrinsiders.com/gm). Thank you!



## Intended Audience

Students in grades 5 through 8

## Program Components

- A teacher's guide, which includes four reproducible student activities
- Sixty (60) 8-page student booklets
- A wall poster
- An educator evaluation form
- An educator reply card

## Need Materials in Spanish?

Visit [gm.com/education](http://gm.com/education) for a downloadable Spanish-language version of this curriculum.

## Curricular Objectives

- Help students consider the current issues surrounding energy today, including increasing global energy demand and environmental and economic impacts
- Explore ways to help reduce petroleum consumption and greenhouse gas emissions by using diverse and renewable energy resources
- Explore ways to conserve energy and become more energy efficient
- Demonstrate the benefits of using renewable energy resources to produce electricity and hydrogen as energy carriers that offer the greatest diversity and lowest environmental impact

## National Education Standards Links

### Science

- Relationships among organisms and their physical environment
- Structure and properties of matter
- Sources and properties of energy

### Geography

- Physical processes that shape patterns on earth's surface
- Characteristics of ecosystems on earth's surface
- Nature, distribution and migration of human populations on earth's surface
- Patterns and networks of economic interdependence on earth's surface
- How human actions modify the physical environment

- How physical systems affect human systems
- Changes that occur in the meaning, use, distribution and importance of resources
- Global development and environmental issues

### United States History

- How the rise of corporations, heavy industry and mechanized farming transformed American society

### Technology

- Relationships among science, technology, society and the individual
- Nature and uses of different forms of technology

### Civics

- Impact of significant political and nonpolitical developments on the United States and other nations

### Economics

- Basic concepts about international economics

## Using the Wall Poster

To introduce this unit, display the wall poster in a visible area of the classroom and ask students what they have heard or read recently concerning energy. Ask students how we get most of the energy we use today. (*from nonrenewable resources*) Why might this be a concern? (*the burning of fossil fuels causes greenhouse gas emissions and has been linked to global warming*)

Other than the environment, see if students are aware of additional concerns regarding energy use in the future (*i.e., growing global populations and economic growth in developing countries, leading to increased global energy demand*). Explain to students that you will be examining these challenges, as well as possible solutions to help meet our future energy needs.

## Incorporating the Student Booklets

The student booklet highlights the challenges and solutions presented in the reproducible activities. We recommend letting students read the booklet first, while generating a list of questions about topics they would like to learn more about. You may also want to send these booklets home with students to spur discussion and interaction with parents.

Over the course of several weeks, have students collect news stories related to energy. Ask students to summarize the articles they select and categorize them in terms of relaying information about one of the specific challenges listed in the booklet, or one of the solutions. Keep a compilation of the articles for the class to reference when learning about related topics, and have students continue adding stories throughout the school year.

## Web Extension

### [gm.com/education](http://gm.com/education)

Please visit GM's education web site to find:

- up-to-date materials and resources for both you and your students
- downloadable files of this curriculum, along with a Spanish-language version
- additional K-12 lesson plans, in English and Spanish, on topics including technology, ethanol, hydrogen and fuel cells
- games designed to be both fun and educational
- interactive photo tours and diagrams, including a comprehensive look at how fuel cells work
- age-appropriate articles and web resources on fuel cells and energy, technology, the environment, careers, making vehicles and more

## Resources & Bibliography

U.S. Department of Energy, Energy Information Administration. [www.eia.doe.gov](http://www.eia.doe.gov)

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. [www.eere.energy.gov/afdc](http://www.eere.energy.gov/afdc)

World Resources Institute, 2005. "Navigating the Numbers: Greenhouse Gas Data and International Climate Policy." [www.wri.org/climate/pubs\\_description.cfm?pid=4093#pdf\\_files](http://www.wri.org/climate/pubs_description.cfm?pid=4093#pdf_files)

NASA Goddard Institute for Space Studies. "Global-Mean Surface Temperature Anomaly." [www.giss.nasa.gov/research/news/20070208](http://www.giss.nasa.gov/research/news/20070208)

*Holt Science & Technology: Physical Science*. Holt, Rinehart and Winston, 2005.

*The Osborne Illustrated Encyclopedia, Science & Technology*. Usborne Publishing, 1996.

## ACTIVITY 1

### What Are the Challenges?

After reading the activity with your class, review the meaning of fossil fuels: energy sources thought to be formed over millions of years from the remains of dead plants and animals. Explain that, through photosynthesis, these plants stored energy from the sun and both captured and stored CO<sub>2</sub> from the atmosphere. By eating the plants, animals then used and stored this energy. When fossil fuels are burned, this energy from the sun and the captured CO<sub>2</sub> are released. Fossil fuels are nonrenewable resources—they cannot be replaced in a short amount of time and their supply is limited.

You may want to have students work in pairs to answer the questions.

#### Answers:

- The Industrial Revolution was a time of great industrial and technological advancement. The petroleum refining, steel manufacturing and electrical power industries emerged. Railroads expanded and millions of people moved to growing cities. The source of light changed from candles to kerosene lamps and then to electric light bulbs. Transportation progressed from walking and horse power to steam-powered locomotives, to electric trolley cars, to gasoline-powered automobiles.
- In the past, a wealthier, heavily industrialized country was associated with more energy-intensive lifestyles; and larger populations led to higher rates of energy consumption in order to meet everyone's needs. Subsequently, further increases in economic wealth have been associated with reductions in energy intensity, or the ratio of energy use to a nation's overall level of output. The reasons include, among others, improvements in energy efficiency or the amount of fuel required to power the nation's factories and transportation system. Energy consumption, however, has continued to rise in the U.S. and other advanced economies, as economies and populations continue to grow, and as more and more people have more and more money to spend on energy for transport, industry and commerce.
- and 4. Answers will vary

### Extension Lessons

**Deforestation & Reforestation:** Ask students to explore the reasons for both deforestation and reforestation, as well as their impacts on greenhouse gas emissions and global climate change.

**China:** This year, 2007, China is projected to surpass the U.S. as the world's largest emitter of greenhouse gases. Have students research China's historical and growing demand for energy. What factors are contributing to this demand, and what are some possible ways it can be met?

### What generates more greenhouse gases than transportation?

According to a United Nations report, the livestock sector—with its direct impact and the impact of necessary feedcrop agriculture—is responsible for creating 9% of human-related carbon dioxide emissions, 65% of human-related nitrous oxide (a greenhouse gas with 296 times the global warming potential of carbon dioxide) and 37% of human-induced methane (with 23 times the warming potential as CO<sub>2</sub>). With increased economic prosperity, global meat production is projected to more than double from 1999 to the year 2050.\*

## ACTIVITY 2

### What Is a Possible Solution?

The key to success in addressing the global climate issue is to diversify away from petroleum to a variety of alternative, environmentally sustainable energy sources that will have lower overall greenhouse gas emissions. It includes efforts to:

- substitute low carbon fuels such as natural gas for high carbon fuels such as coal and petroleum;
- capture and sequester the carbon that is used to generate electric power from carbon fuels such as coal and petroleum;
- increase the efficiency with which energy is used to power the nation's factories and transportation sectors; and
- conserve the nation's and world's scarce energy resources by encouraging every citizen to be prudent and mindful of his/her energy use in driving and living habits.

Introduce this lesson by showing students some grass or weed clippings from outside and some garbage from the classroom bin. Ask students what these two piles have in common. Tell your class that they can both be used for energy and they both store CO<sub>2</sub>. They are types of a renewable energy resource known as biomass.

After reviewing the activity sheet together, review the process of photosynthesis as it relates to producing ethanol from corn:

- Energy from the sun is taken into the corn plant's cells and stored.
- This energy separates the oxygen from water (H<sub>2</sub>O), and the oxygen is released by the plant.
- The carbon dioxide (CO<sub>2</sub>) that is taken in by the plant combines with the hydrogen from water.
- The hydrogen and carbon dioxide join to form glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>), a type of sugar that is the food for the plant.
- The sugars and related starches from within the corn kernel are refined into liquid ethanol (C<sub>2</sub>H<sub>5</sub>OH) that can be used for fuel.

Biomass is a renewable energy resource. Biomass can be burned to release the energy that it holds. When burned, biomass does release carbon dioxide, but when biomass crops are grown, a nearly equal amount of carbon dioxide is captured through photosynthesis.

#### Answers:

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### Extension Lessons

**Carbon Capture:** Ask students to research carbon capture. Where and in what capacity can carbon capture be utilized? What improvements and developments are being researched on this front?

**Footprints:** Have students measure their ecological footprint ([www.earthday.net/footprint](http://www.earthday.net/footprint)) and/or carbon footprint ([www.carbonfootprint.com](http://www.carbonfootprint.com)). What measures can they take personally to help reduce their impact on the environment? Discuss how recycling and reusing can play a major role in reducing one's carbon/ecological footprint.

\* Livestock's long shadow—environmental issues and options.

## ACTIVITY 1

NAME \_\_\_\_\_

### What Are the Challenges?

Texting your friends, typing your report, buying new jeans, listening to your favorite song...for everything we do, we rely on energy. As we look to the future, will we have enough energy to meet all of our needs?

Will things really change that much in the next 10, 20 or 30 years? What challenges are we facing?

There are two main areas of concern when thinking about energy today:

- greenhouse gas emissions and global climate change
- population and economic growth, leading to increased energy demand

### Greenhouse Gas Emissions and Global Climate Change

Greenhouse gases are gases such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and water vapor. These gases let sunlight into the atmosphere. When the sunlight hits the earth's surface, some of its heat is reflected back towards space. Greenhouse gases absorb this heat and trap it in the atmosphere. The temperature of the earth would stay just about constant if the amount of energy sent from the sun to the earth was almost the same as the amount of heat reflected back towards space.

Without greenhouse gases that occur naturally (not man-made), the earth would not be warm enough for us to live. One way man-made greenhouse gases are emitted, or released, is by burning fossil fuels, like coal, petroleum and natural gas.

The concentration of greenhouse gases in the atmosphere is increasing. Concentration of carbon dioxide in the atmosphere has risen 35% since the start of the Industrial Revolution. Between the years 2000 and 2025, global greenhouse gas emissions are projected, or estimated, to rise 57%.

We rely mainly on fossil fuels for our energy. Therefore, greenhouse gas emissions result from most of our daily activities.

### Population and Economic Growth

The countries that tend to emit the most greenhouse gases are countries with large populations or large economies, or both. A country's economy is its system of producing, distributing and consuming wealth. In years to come, populations are expected to increase. Plus, economic growth, especially in developing countries, will place the greatest demand on global energy resources ever experienced.

### By the year 2030:

- the world's population is expected to be about one third larger than it is today. That's two billion more people—the equivalent of almost two more China's.
- energy demand worldwide is projected to be more than 50% higher than it was in 2006, with most of that growth coming from developing Asian countries, in particular China and India.

Today, only 12% of the people in the world own automobiles—88% do not. But, as the population increases and economies thrive, more people are expected to own automobiles.

Almost all of the energy used to power automobiles today comes from petroleum. However, it's not likely that petroleum alone is going to be able to supply all of the world's growing automotive energy needs. We have to find a way to meet the demand for more energy. Yet, we also need to address the long-term concerns about the environment.

*Answer the following questions on a separate piece of paper.*

1. Why do you think carbon dioxide (CO<sub>2</sub>) emissions have been increasing since the Industrial Revolution?
2. Why would a country with a large population and strong economy tend to emit more greenhouse gases?
3. How old will you be in the year 2030? If we continue to meet our energy needs with fossil fuels, what might be different about our lifestyles and why?
4. What would you like life to be like in 2030? What energy and other natural resources should we be using then?

### Think about it!

Each year, we exhale about 500 lbs of CO<sub>2</sub>!

## ACTIVITY 3

### Power in Variety

This exercise explores how we can make use of energy carriers derived from different resources to help meet regional transportation and energy needs. Electricity and hydrogen, both energy carriers, can be produced from a variety of sources, including renewables. In terms of electricity, adding to its attractiveness is the fact that there is already an existing, global infrastructure with clearly-defined standards.

#### Answers:

1. biomass, solar, wind, hydropower
2. they can be made from the best local energy source; they can be produced from a variety of energy sources, including renewable sources; they emit significantly fewer greenhouse gases when produced from a renewable source
3. coal is a nonrenewable resource; it is also a fossil fuel, which means that it emits greenhouse gases when burned

### Extension Lessons

**Energy Lifecycle:** After reviewing forms of energy with your class, have students create an energy lifecycle following a fuel source from its origin (energy from the sun) through its end use.

**Inside Look:** Working in pairs or groups, ask students to research and present to the class information on how solar panels, wind turbines, nuclear power plants and other related energy systems work.

### Ethanol Fast Facts

- Ethanol is high octane (approximately 104)—it contains 35% oxygen, so it burns cleaner than gasoline (approximately 86 octane).
- It is nontoxic, biodegradable and does not contaminate water.
- Ethanol accounts for approximately 90% of the world's biofuel production.
- Five billion gallons of this renewable fuel were produced in 2006 in the U.S.

For additional lesson plans and information on ethanol, hydrogen, fuel cells and advanced vehicle technology, visit [gm.com/education](http://gm.com/education).



## ACTIVITY 4

### Earn Points with Technology

This activity explores the potential for displacing petroleum with biofuels and electricity. This requires new production and infrastructure for fuels like ethanol and hydrogen, as well as new production capabilities for enabling technologies like advanced batteries, fuel cells and hydrogen storage devices. The ability for these technologies to significantly impact and reduce man-made greenhouse gas emissions encourages involvement from governments, industry and consumers alike. Once new technologies are in the marketplace, they will have significant impact if people buy them in large volume.

The Extended-Range Electric Vehicle described in the activity is based on the Chevy Volt Concept. For people driving 40 miles a day, the Volt will use zero gasoline, produce zero emissions at its tailpipe and could nearly eliminate going to the gas station altogether. Extended-Range Electric Vehicles will be introduced into the market as the required battery technology becomes available.

After students review the activity sheet, ask them to plot the different resulting combinations on a separate piece of paper showing a continuum of environmental friendliness. Then, divide students into teams to research technological developments of each of the four vehicle types described.

As a reward, have students play the Find-A-Fuel game at [gm.com/education](http://gm.com/education) in which they race these different types of vehicles by gathering the appropriate fuel sources along the way.

### Extension Lessons

**Green Schools and Homes:** Ask students to research grass-roots initiatives of schools or individual families in the quest to be environmentally friendly. They should include examples of recycling and reusing resources as part of the solution.

**Innovation Cycle:** Innovation follows a cycle with four stages: 1. invention, 2. development, 3. commercialization and 4. refinement. Have students examine a product or technological advancement in terms of this cycle. Or, students can develop a new concept and plot possible benchmarks expected in the cycle.

### Hydrogen Fast Facts

- Hydrogen is the lightest and simplest element on the periodic table, with only one proton, one electron and no neutrons.
- It is the source of all the energy we receive from the sun, which is a ball of hydrogen and helium gases.
- Hydrogen has the highest energy content of any known fuel.
- It is considered one of the building blocks of life (even our bodies are about 10% hydrogen).





## ACTIVITY 3

NAME \_\_\_\_\_

### Power in Variety

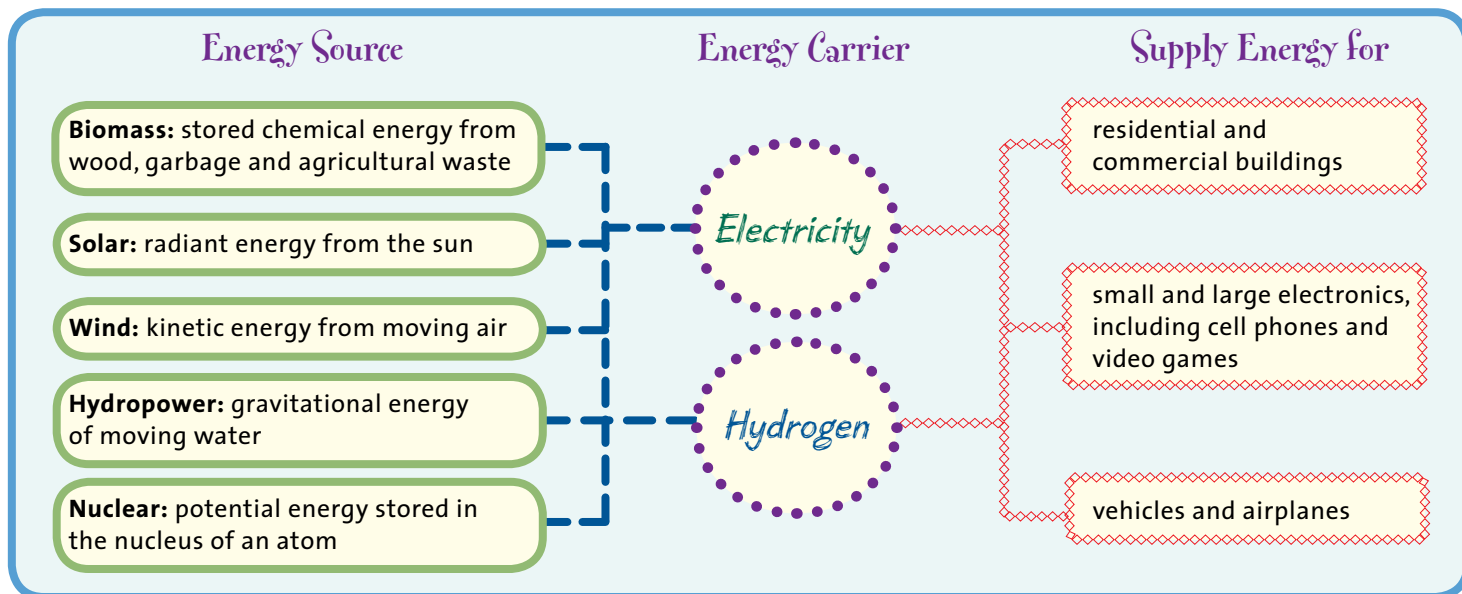
It may be hard to believe, but only one out of 10 rural homes in the U.S. had electric power as late as 1930. Most of the electricity we use today is made from nonrenewable resources, like coal, petroleum and natural gas. Do you think it's possible to change the source of that electricity? Can we generate more electricity from renewable resources? Can we use a variety of energy sources so that, depending on where you live, the best local energy source could be used?

Energy sources can be either renewable or nonrenewable. Renewable sources are those that can be replenished in a short period of time. Nonrenewable sources are those that *can't* be replaced in a short amount of time; their supply is limited. Both types can be converted into electricity and hydrogen.

Electricity and hydrogen are *energy carriers*. They store, move and deliver energy in a form that's easy to use. But, first we have to use another energy source to make electricity and hydrogen. Electricity and hydrogen are considered ideal energy carriers because they can be made from a variety of sources. They can also supply energy for many different uses.

Electrical energy is the energy of moving *electrons*, the negatively-charged particles of *atoms*. Electricity is the flow of electrical power or charge. Different sources of energy, like the ones below, can be used to power a *generator*, creating electrical energy.

Nuclear energy is generated from radioactive elements, such as uranium. It is considered a nonrenewable resource because the supply of these elements is limited.



Hydrogen is the most abundant element in the universe. Like electricity, different sources of energy, such as wind power, can be used to produce hydrogen. Hydrogen can be produced by separating it from other elements, such as water (H<sub>2</sub>O). To use it for energy, hydrogen is added to a *fuel cell*. The fuel cell, which is like a battery, combines the hydrogen with oxygen and creates electricity. Then, the fuel cell can be used to power anything that uses batteries or electricity—from cell phones to vehicles to homes.

Answer the following questions on a separate piece of paper.

1. When electricity and hydrogen are made from a renewable source, they emit significantly fewer greenhouse gases. Which energy sources mentioned above are renewable?
2. What are the benefits of electricity and hydrogen?
3. In 2005, almost half of the electricity generated in the U.S. came from coal. What are some of the reasons we should try to generate electricity from different sources of energy?

### Research your local electric company:

What energy resource(s) is(are) used to generate your electricity? Does the company offer a renewable source as an alternative?