HS Human Actions and Earth's Resources

Dana Desonie

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AUTHOR
Dana Desonie

CONTRIBUTOR
Mary Lusk

CHAPTER 1 HS Human Actions and Earth's Resources

CHAPTER OUTLINE

This landscape in west Texas and southeastern New Mexico is pock-marked with oil wells and drilling structures connected by roads. The Yates Oil Field exploits petroleum from the Permian Basin, one of the highest producing oil provinces in North America. In the image it's possible to see the basin's folded sedimentary rocks. At the base of the basin is ancient continental crust that filled with sediments as the region was covered by shallow seas and then exposed several times during the Paleozoic Era. The thick Permian sediments were organic-rich carbonates and salts that were buried and later folded. Oil was produced and later trapped by the rock layer. Oil was first discovered on the Yates land in 1926, and by 1995 the land had produced more than 2 billion barrels of oil. The oil field is still productive, but at a diminished rate. While nearly 1 billion barrels is estimated to be still in the ground, it is more difficult to extract than the oil that was produced earlier.

1.1 Use and Conservation of Resources

Lesson Objectives

- Discuss some natural resources used to make common objects.
- Describe some ways to conserve natural resources.

Vocabulary

- conserve
- export
- import
- timber

Introduction

Natural resources may be living or non-living. Their value may be tangible, such as the price of an ounce of gold, or intangible, like the psychological value of being able to visit pristine natural areas. Some natural resources must be used and used wisely, but some must be preserved to maintain their value.

Mystery in the Forest

Like all forests, the Monongahela National Forest of West Virginia is an important natural resource. A forest is a resource in ways that are obvious and ways that are not so obvious. This forest is used for many things including:

- Recreation, such as hiking, camping, and picnicking.
- Habitat for many organisms, including nine endangered species and 50 species of rare plants.
- Streams [207 kilometers (129 miles)] for fishing, particularly trout fishing.
- Wildlife management areas for hunting deer, squirrels, turkeys, rabbits, mink, and foxes.
- Mineral and energy resources such as coal, gas, limestone, and gravel.
- Hardwood trees used for **timber**, which brings in over $7 million a year.

But Monongahela National Forest has a problem; for several years, trees in the forest have not grown well. What are some reasons that trees might not grow well (**Figure** 1.1)?

Scientists have been working for several years to solve the mystery. The scientists suspected that the soil is missing nutrients that the trees and other plants need to grow. Can you design an experiment that scientists could do to test this hypothesis? (There is a clue in the figure caption above.)

The scientists sampled the soil and tested it for important nutrients. They discovered that the soil has very low levels of plant nutrients, such as magnesium and calcium. Can you develop a hypothesis for why these nutrients might be missing from the soil? The scientists thought that air pollution from nearby factories had released chemicals into the environment that removed the nutrients from the soil and carried them away. How would the scientists test that hypothesis?

Scientists in the Monongahela National Forest are still researching the missing plant nutrients. They are trying to learn what they can do to help keep the nutrients in the soil so the trees will grow better.

FIGURE 1.1

The Monongahela National Forest in West Virginia contains many natural resources. Notice the air pollution that obscures the view.

Like the Monongahela National Forest, people use parts of the Earth for many reasons, such as food, water, building materials, timber, recreation, and energy (**Figure** 1.2).

FIGURE 1.2

We use Earth

As you've already learned, human activities can degrade natural resources, just like air pollution from factories is speeding up the loss of soil nutrients in West Virginia (**Figure** 1.3).

FIGURE 1.3

Severe pollution can lead to drastic environmental damage and loss of natural resources. This forest in Europe was damaged by air pollution.

For natural resources to continue to be available, they need to be protected. We also need to **conserve** natural resources so they will last longer. When we practice conservation, we make sure resources will be available in the future, both for ourselves and for other organisms.

Renewable versus Non-Renewable Resources

In the Earth's Energy chapter, energy resources were classified as renewable or non-renewable. How do you think other natural resources, such as minerals and forests, are classified? Like energy resources, all natural resources are divided into renewable and non-renewable. Can you define these terms?

Renewable resources can be regenerated or grown so rapidly that they reappear at the same rate or even faster as they are being used (**Figure** 1.4). Are forests a renewable resource? Why are they a renewable resource? Why aren't they a renewable resource? Although new trees can grow to replace logged trees, their growth is often too slow for the trees to be of use for a long time. Loggers just move to a new area rather than wait for the forest to regenerate.

FIGURE 1.4

An old growth forest, like the Tongass National Forest in Alaska, is a complex ecosystem with many types of plants and animals. When a forest is destroyed by logging, it takes hundreds or thousands of years for the forest to regenerate.

Other examples of resources that are renewable but not entirely renewable include soil, wildlife, and water. How do these resources fit in both categories? Soil has a very slow renewal rate, so they are often non-renewable. Fish and other wildlife can reproduce and so are a renewable resource, yet it is possible to take so many of these creatures that the populations are not able to rebound, making them a non-renewable resource (**Figure** 1.5). Organisms can be over-hunted, over-fished or have populations decline because of habitat loss so that their numbers go so low they are no longer a renewable resource.

FIGURE 1.5

Chimpanzees are eaten and taken as pets so their numbers in the wild are declining.

Non-renewable resources are resources that cannot be regenerated on a useful timescale. Fossil fuels and most minerals are non-renewable resources. We can (and eventually will) run out of these resources.

Common Materials We Use from the Earth

People depend on natural resources for just about everything that keeps us fed and sheltered, as well as for the things that keep us entertained. Every person in the United States uses about 20,000 kilograms (40,000 pounds) of minerals every year for a wide range of products, such as cell phones, TVs, jewelry, and cars. **Table** 1.1 shows some common objects, the materials they are made from and whether they are renewable or non-renewable.

TABLE 1.1: Common Objects We Use From the Earth

Common Object	Natural Resources Used	Are These Resources Renewable or Non-renewable?
Cars	15 different metals, such as iron, lead, and chromium to make the body.	Non-renewable
Jewelry	Precious metals like gold, silver, and platinum. Gems like diamonds, rubies, emeralds, turquoise.	Non-renewable
Electronic Appliances (TV's, computers, DVD players, cell phones, etc.)	Many different metals, like copper, mercury, gold.	Non-renewable
Clothing	Soil to grow fibers such as cotton. Sunlight for the plants to grow.	Renewable

TABLE 1.1: (continued)

Common Object	Natural Resources Used	Are These Resources Renewable or Non-renewable?
	Animals for fur and leather.	
Food	Soil to grow plants.	Renewable
	Wildlife and agricultural animals.	
Bottled Water	Water from streams or springs.	Non-renewable and Renewable
	Petroleum products to make plastic bottles.	
Gasoline	Petroleum drilled from wells.	Non-renewable
Household Electricity	Coal, natural gas, solar power, wind power, hydroelectric power.	Non-renewable and Renewable
Paper	Trees; Sunlight Soil.	Renewable
Houses	Trees for timber.	Non-renewable and Renewable
	Rocks and minerals for construction materials, for example, granite, gravel, sand.	

Resource Availability

From the table above you can see that many of the resources we depend on are non-renewable. Non-renewable resources vary in their availability; some are very abundant and others are rare. Materials, such as gravel or sand are technically non-renewable but are so abundant that running out is no issue. Some resources are truly limited in quantity: When they are gone, they are gone and something must be found that will replace them. There are even resources, such as diamonds and rubies, that are valuable in part because they are so rare.

Besides abundance, resource value is determined by how easy it is to locate and extract. If a resource is difficult to use, it will not be used until the price for that resource becomes so great that it is worth paying for. For example, the oceans are filled with an abundant supply of water, but desalination is costly, so it is used only where water is really limited (**Figure** 1.6). As the cost of desalination plants comes down, more will likely be built.

FIGURE 1.6

Tampa Bay, Florida, has one of the few desalination plants in the United States.

Politics is also part of determining resource availability and cost. Nations that have a desired resource in abundance will often **export** that resource to other countries, while countries that need that resource must **import** it from one of the countries that produces it. This situation is a potential source of economic and political trouble.

Of course the greatest example of this is oil. Only 11 countries have nearly 80% of all of the world's oil (**Figure** 1.7). However, the biggest users of oil, the United States, China, and Japan, are all located outside this oil-rich region. This leads to a situation in which the availability and price of the oil is determined largely by one set of countries that have their own interests to look out for. The result has sometimes been war, which may have been attributed to all sorts of reasons, but at the bottom, the reason is oil.

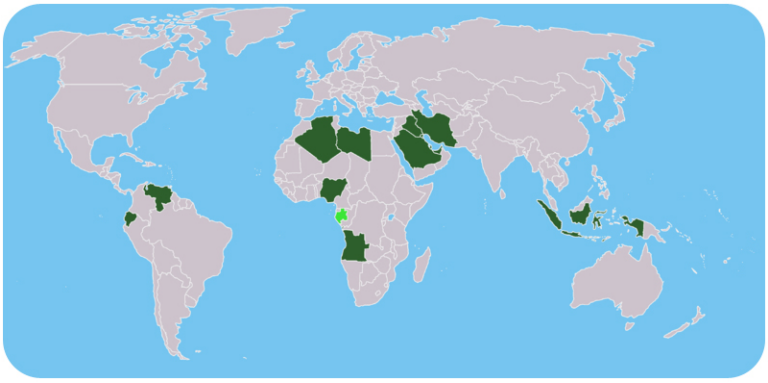

FIGURE 1.7

The nations in green are the 11 biggest producers of oil; they are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

The topic of overconsumption was touched on in the Ecosystems and Human Populations chapter. Many people in developed countries, such as the United States and most of Europe, use many more natural resources than people in many other countries. We have many luxury and recreational items, and it is often cheaper for us to throw something away than to fix it or just hang on to it for a while longer. This consumerism leads to greater resource use, but it also leads to more waste. Pollution from discarded materials degrades the land, air, and water (**Figure** 1.8).

FIGURE 1.8

Pollution from discarded materials degrades the environment and reduces the availability of natural resources.

Natural resource use is generally lower in developing countries because people cannot afford many products. Some of these nations export natural resources to the developed world since their deposits may be richer and the cost of labor lower. Environmental regulations are often more lax, further lowering the cost of resource extraction.

Besides obtaining resources, we also dump waste on these nations. Many of our electronic wastes, which we think are being recycled, end up in developing countries where they pose a problem for human health and the environment

(**Figure** 1.9).

FIGURE 1.9

Electronic wastes are sent to developing nations where people pick through them for valuable materials. These wastes contain many toxic compounds and are hazardous.

Conserving Natural Resources

So that people in developed nations maintain a good lifestyle and people in developing nations have the ability to improve their lifestyles, natural resources must be conserved and protected (**Figure** 1.10). People are researching ways to find renewable alternatives to non-renewable resources. Here is a checklist of ways to conserve resources:

- Buy less stuff (use items as long as you can, and ask yourself if you really need something new).
- Reduce excess packaging (drink tap water instead of water from plastic bottles).
- Recycle materials such as metal cans, old cell phones, and plastic bottles.
- Purchase products made from recycled materials.
- Reduce pollution so that resources are maintained.
- Prevent soil erosion.
- Plant new trees to replace those that are cut down.
- Drive cars less, take public transportation, bicycle, or walk.
- Conserve energy at home (turn out lights when they are not needed).

FIGURE 1.10
Recycling can help conserve natural resources.

National Geographic videos found on this site in Environment Videos, Environmental Threats, Deforestation: http://video.nationalgeographic.com/video/player/environment/

- "Sustainable Logging"

Or Environment Videos, Habitats, Rainforest:http://video.nationalgeographic.com/video/player/environment/

- "Mamirarua" is a sustainable development reserve that is protecting the Amazon
- "Vancouver Rain Forest" explores an alliance between conservationists and logging companies

Or find ways to go green from National Geographic videos, Environment Videos, Going Green, http://video.nationalgeographic.com/video/player/environment/

- The problem with plastic bags is discussed in this Conservation in action, "Edward Norton: Bag the Bag"
- Trying to mitigate problems caused by intensive logging in Ecuador while helping the people who live there improve their standards of living is in "Ecuador Conservation"

Lesson Summary

- We use natural resources for many things. Natural resources give us food, water, recreation, energy, building materials, and luxury items.
- Many resources vary in their availability throughout the world. Some are rare, difficult to get, or in short supply.
- Natural resources must be preserved and protected from pollution and overuse.
- Buying fewer new products and recycling will help to conserve resources.

Review Questions

1. List five general things we get from natural resources.

2. Are forests a renewable resource? Are they ordinarily used in a renewable way? How can forests be used more sustainably?

3. Of what value are forests besides for wood? Is there a value to forests that is not a monetary value? How much is that value considered when forests are being used for their resources?

4. How are fish and other wildlife renewable resources? How are they nonrenewable resources?

5. What is overconsumption? How does overconsumption mirror overpopulation?

6. If a product is recycled, is anything lost in terms of material or energy?

7. Resource X is scarce except in Nation A. Many nations want to use Resource X. How does politics play into the ability of other nations to get access to the resource?

Further Reading / Supplemental Links

- Maps of Renewable Resources in the United States http://www.nrel.gov/gis/maps.html

Points to Consider

- Could a renewable resource ever become non-renewable?
- What are some of the intangible values that a natural resource might have?
- Do you think about the material and energy resources you use as you use them?
- Which is more sustainable: using renewable resources or non-renewable resources? Why?

1.2 Energy Conservation

Lesson Objectives

- Discuss why it takes energy to get energy and why some forms of energy are more useful than others.
- Describe some ways to conserve energy or to use energy more efficiently.

Vocabulary

- energy efficiency
- net energy
- net-energy ratio

Introduction

The Earth's Energy chapter deals with many aspects of energy and energy use. It would be good to review it before embarking on this lesson on energy conservation. Getting and using natural energy sources is a lot like spending money to get money. To get energy, we must use a lot of energy. Finding an energy source, extracting it, refining it, and transporting it to where it will be used all require energy. One way to keep the energy costs of energy down is to use energy more efficiently: to conserve energy.

Obtaining Energy

Net energy is the amount of useable energy available from a resource after subtracting the amount of energy needed to make the energy from that resource available. For example, every 5 barrels of oil that are made available for use require 1 barrel for extracting and refining the petroleum. What is the net energy from this process? About 4 barrels (5 barrels minus 1 barrel).

What happens if the energy needed to extract and refine oil increases? Why might that happen? The energy cost of an energy resource increases when the easy deposits of that resource have already been consumed. For example, if all the nearshore petroleum in a region has been extracted, more costly drilling must take place further offshore (**Figure** 1.11). If the energy cost of obtaining energy increases, the resource will be used even faster.

The **net-energy ratio** demonstrates the difference between the amount of energy available in a resource and the amount of energy used to get it. If it takes 8 units of energy to make available 10 units of energy, then the net-energy ratio is 10/8 or 1.25. What does a net-energy ratio larger than 1 mean? What if the net-energy ratio is less than 1? A net-energy ratio larger than 1 means that there is a net gain in usable energy; a net-energy ratio smaller than one means there is an overall energy loss.

Table 1.2 1.2 below shows the net-energy ratios for some common energy sources.

TABLE 1.2: Net-energy Ratios for Common Energy Sources

Energy Source	Net-energy Ratio
Solar Energy	5.8
Natural Gas	4.9
Petroleum	4.5

TABLE 1.2: (continued)

Energy Source	Net-energy Ratio
Coal-fired Electricity	2.5-5.1

FIGURE 1.11

Offshore drilling is taking place in deeper water than before. It takes a lot of energy to build a deep drilling platform and to run it.

Notice from the table that solar energy yields much more net energy than other sources. This is because it takes very little energy to get usable solar energy. Sunshine is abundant and does not need to be found, extracted, or transported very far. The range for coal-fired electricity is because of the differing costs of transporting the coal. What does this suggest about using coal to generate electricity? The efficiency is greater in areas where the coal is locally mined and does not have to be transported great distances (**Figure** 1.12).

FIGURE 1.12

Obtaining coal for energy takes a lot of energy. The coal must be located, extracted, refined, and transported.

This is not to say that solar energy is less expensive than other types of energy. The cost of energy is dependent on lots of different factors, such as the cost of the equipment needed to harness the energy. If solar power cost less to use, it would be more widespread.

Energy Efficiency

Energy efficiency describes how much useful work is extracted from one unit of energy. Remember that although energy is not created or destroyed, it's just transferred from one form to another, some energy is nearly always lost in the transfer as heat. By saying that the work must be useful subtracts the energy that is lost to non-useful work. For example, some energy may not be doing useful work if the equipment is not running well (maybe a piston is moving sideways a bit rather than just up and down).

Higher energy efficiency is desirable because:

- Less energy is being wasted.
- Non-renewable resources will last longer.
- The cost is kept lower.

Because so much of the energy we use is from fossil fuels, we need to be especially concerned about using them efficiently. Sometimes our choices affect energy efficiency. For example, transportation by cars and airplanes is less energy-efficient than transportation by boats and trains. Compact fluorescent light bulbs are more efficient than incandescent light bulbs (**Figure** 1.13).

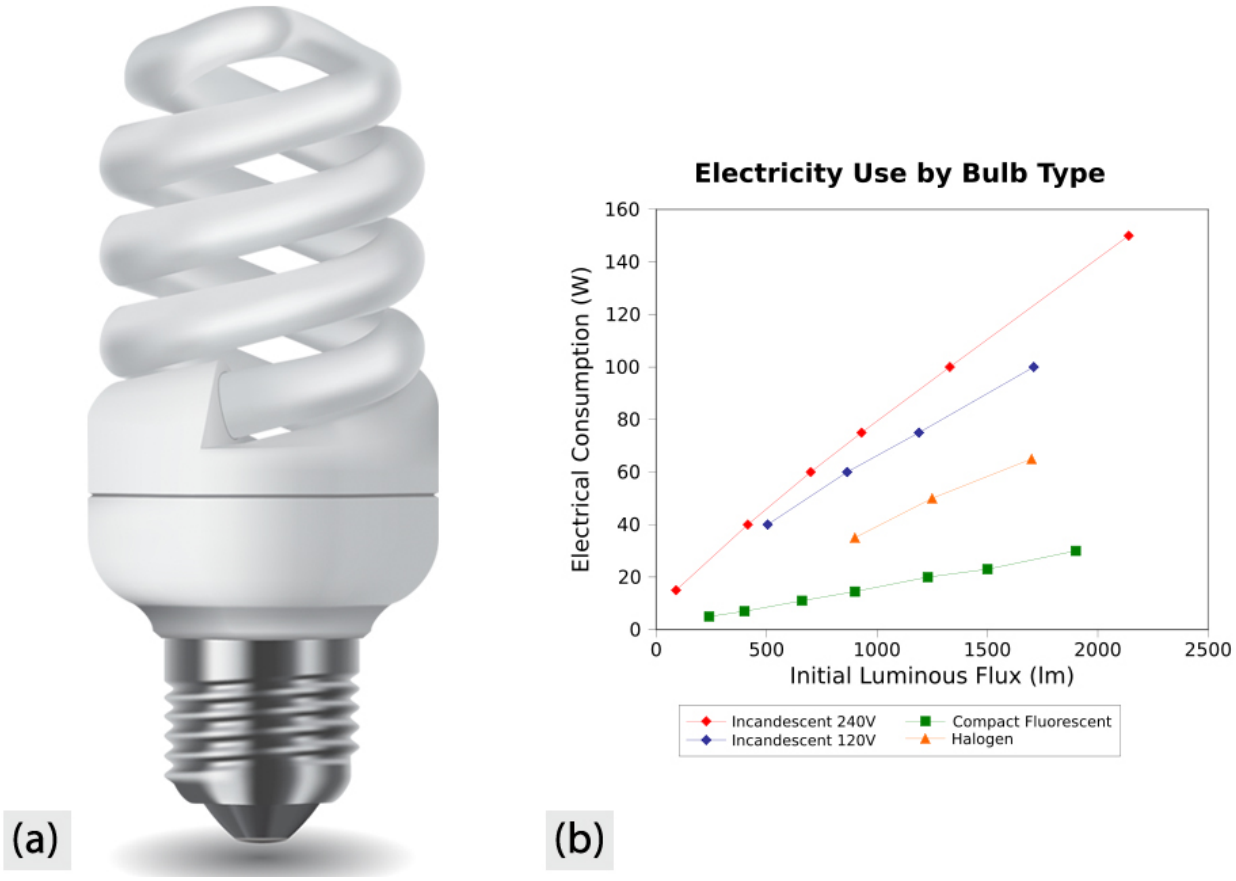

FIGURE 1.13

(a) A compact fluorescent light bulb. (b) Compact fluorescent bulbs use less electricity to produce light than incandescent or halogen bulbs.

Energy Conservation

What benefits are there from energy conservation? Conserving energy means that less energy is needed, which reduces costs, ensures that non-renewable energy sources will last longer, and reduces political and environmental impacts.

What are the two ways that energy can be conserved? (1) Use less energy, and (2) use energy more efficiently.

The pie chart (**Figure** 1.14) shows how energy is used in the United States.

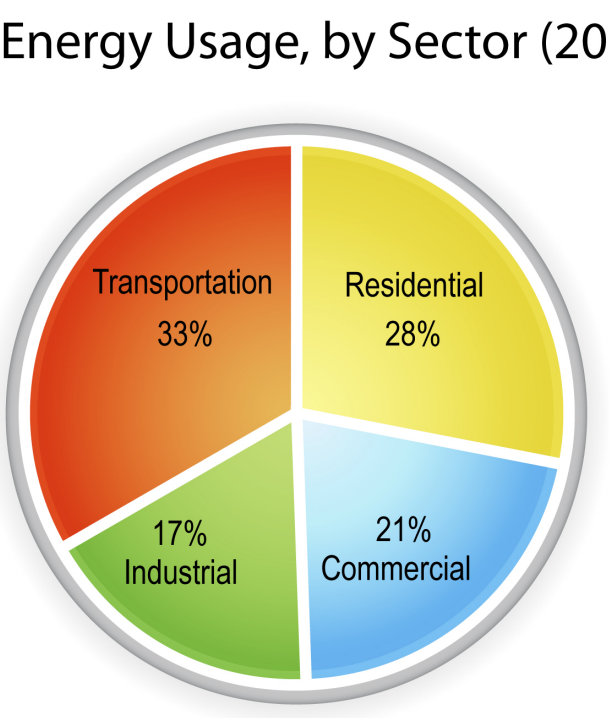

FIGURE 1.14

Almost one-half of the energy used in the United States is for transportation and home use. This means individual choices can make a big impact on energy conservation.

Table 1.3 shows some ways that people can decrease energy use and use energy more efficiently in transportation, residences, industries, and office settings.

TABLE 1.3: This is where to put a caption, if any

Where Energy is Used	How We Can Use Less Energy	How We Can Use Energy More Efficiently
Transportation	Ride a bike or walk instead of taking a car.	Increase fuel efficiency in cars.
	Reduce the number of trips you make.	Buy and drive smaller cars.
	Use public transportation.	Build cars from lighter and stronger materials.
		Drive at speeds at or below 90 kilometers per hour (55 miles per hour).
Residential	Turn off lights when not in a room.	Replace old appliances with newer more efficient models.
	Only run appliances when necessary.	Insulate your home.
	Unplug appliances when not in use.	Make sure windows and doors are well sealed.
	Wear a sweater instead of turning up heat.	Use LED bulbs if available, or compact fluorescent light bulbs (and dispose of properly!).
	Use fans instead of turning down air conditioner.	

TABLE 1.3: (continued)

Where Energy is Used	How We Can Use Less Energy	How We Can Use Energy More Efficiently
	Engage in activities that do not involve electronics.	
	Rely on sunlight instead of artificial light.	
Industrial	Recycle materials like soda cans and steel.	Practice conservation in factories.
	Reduce use of plastic, paper, and metal materials.	Reuse materials.
		Design equipment to be more efficient.
Commercial (businesses, shopping areas, etc.)	Turn off appliances and equipment when not in use.	Use fluorescent lighting.
		Set thermostats to automatically turn off heat or air conditioning when buildings are closed.

Using less energy, or using energy more efficiently, will help conserve our energy resources. Since many of the energy resources we depend upon are non-renewable, we need to make sure that we waste them as little as possible.

Energy saving tips from the U.S. Department of Energy: http://www.energy.gov/energytips.htm

The U.S. Department of Energy has a video to let you know how a home energy audit will help you to make your home more energy efficient. Be sure to follow links to the *Do it yourself* page. http://www.energysavers.gov/your_home/energy_audits/index.cfm/mytopic=11160

Lesson Summary

- It takes energy to get energy. Net energy refers to the amount of energy left for use after we expend energy to get, transport, and refine other forms of energy.
- Energy resources can be conserved by reducing energy use.
- Energy can be used more efficiently by getting more work out of each unit of energy.
- There are many ways for an individual to conserve energy.

Review Questions

1. Define net energy.

2. Why does solar power have a higher net-energy ratio than coal-fired electricity?

3. Some coal-fired electricity has a net-energy ratio of 2.5. Explain what this means. When is coal a good choice for generating electricity? When is coal not a good choice for generating electricity?

4. What are two ways you can use less energy in your home?

5. What are two ways that energy can be conserved?

6. Why is it especially important to not waste energy from fossil fuels?

7. Why are trains much more efficient than trucks for transporting items? Why are boats more efficient than airplanes or cars for travel?

8. If you were to replace a 240V incandescent bulb with a compact fluorescent bulb with an initial luminous flux of about 1500 lm, how much would you decrease electrical consumption?

Points to Consider

- If it takes energy to get energy, then what are the best choices for types of energy?
- Put each of these actions in order from most important to least: choosing a sustainable form of energy, increasing energy efficiency, conserving energy use. Explain the order you chose.
- Could everyone in the world use as much energy as a person in the United States does each day? Why or why not?

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