

Energy: Conservation and Transfer



Energy: Conservation and Transfer

8.P.2 Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources.

8.P.2.1 Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.

8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.

Check the Source!

How do people use energy?

- Energy is the capacity to do work.
- People use energy to heat and cool their homes, provide light, manufacture goods, produce and prepare food, and move vehicles.

Where does all the energy you use come from?



What are sources of energy?



- The sun is Earth's main source of energy. When it reaches Earth, the sun's energy can be stored in different ways.
- Useful chemical energy is sometimes stored in minerals. Earth's internal heat, or geothermal energy, is another energy source.
- An *energy source* is an available source of stored energy that humans can use.

What are sources of energy?



- A **renewable resource** is an energy source that can be easily reproduced or replaced by nature.
- Renewable resources are replaced at a rate equal to or greater than the rate at which they are used.
- Some examples of renewable resources are sunlight, wind, trees, and crops.



WIND



What are sources of energy?

- A **nonrenewable resource** is an energy source that cannot be produced, grown, or restored as fast as it is used.
- For example, minerals such as uranium are nonrenewable because they can no longer be formed.
- Other examples of nonrenewable resources are coal, petroleum, and natural gas. They formed over millions of years below Earth's surface.



Running out of Gas!

What are some fossil fuels?



- **Fossil fuels** are energy resources made from carbon-rich plant and animal remains.
- Fossil fuels are nonrenewable because they take millions of years to form.
- Burning fossil fuels produces carbon dioxide, a greenhouse gas, as well as harmful acids and other forms of pollution.

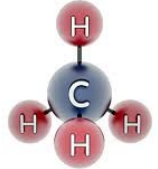
What are some fossil fuels?

- Coal is a sedimentary rock formed from the remains of dead plants at the bottom of ancient swamps.
- Coal mining can involve removing soil and rocks or creating deep mines.
- These processes can destroy landscapes and pollute water supplies.



What are some fossil fuels?

- Some fossil fuels are gases that became trapped in rock formations.
- Methane is the main component of natural gas.
- Natural gas burns more cleanly than other fossil fuels. However, it does produce carbon dioxide upon burning, and leaks can be dangerous.



What are some fossil fuels?



- *Petroleum* means “rock oil.” It formed from the remains of single-celled aquatic organisms that lived long ago.
- After petroleum is mined, it is separated into fuels such as gasoline, diesel, and jet fuel.
- Transporting oil can result in spills that pollute the environment and harm wildlife. Burning petroleum produces pollutants.

What are some fossil fuels?

- Natural gas and petroleum are formed from buried organic matter.



What transformations do fossil fuels undergo?

- First, raw fossil fuels are obtained by drilling or mining.
- Then, they are transported, converted into useful forms, stored, and burned for energy.
- Each transformation can potentially affect the environment in negative ways.



Nature's Storehouse

What are some alternative sources of energy?

- An alternative energy source is a resource that can be used in place of fossil fuels.
- Solar energy is renewable energy from the sun that can be converted into electrical energy. Solar energy is free and clean.
- However, the technologies for solar energy aren't widely used. Also, sunlight does not fall evenly over Earth.



What are some alternative sources of energy?

- Splitting the nuclei of a kilogram of uranium atoms releases thousands of times more energy than burning the same mass of coal releases.
- Nuclear energy is nonrenewable because minerals in Earth's crust cannot be replaced.
- Nuclear power plants do not produce carbon dioxide, but they produce harmful radioactive wastes that must be safely stored.



What are some alternative sources of energy?

- Hydroelectric energy is energy from fast-moving rivers or water flowing downhill through dams.
- Hydroelectric energy is powered by the water cycle, so it is a renewable resource.
- However, flooding the land to produce reservoirs can destroy habitats, and dams can disrupt migratory paths of fish and lead to erosion.



What are some alternative sources of energy?

- Wind energy is a renewable resource generated when the blades of wind turbines turn.
- Wind energy doesn't produce any pollution.
- However, it depends on strong winds and can harm birds that fly too close to the blades.



What are some alternative sources of energy?

- Geothermal energy is extracted from heat stored within Earth.
- It is available near hot springs, geysers, or active volcanoes.
- Geothermal energy is renewable, but it is found only in specific areas on Earth.

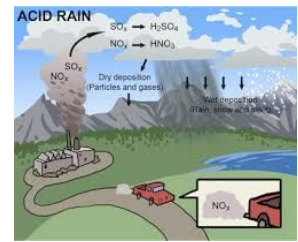


What are some alternative sources of energy?

- Biomass is a renewable resource that includes living or recently dead organic material that can be used as a fuel.
- Examples of biomass are trees, crops, and decaying organic matter.
- However, burning biomass releases carbon dioxide.



Acid Rain



- Burning fossil fuels produces sulfur dioxide and nitrogen oxides. Acid rain forms when these gases combine with water in the air and fall to Earth as rain.
- Acid rain harms aquatic life, damages the leaves of trees, and causes substances toxic to trees to be released from the soil.
- The acids in acid rain react with metals, marble, and stone, affecting buildings and statues.



It's Only Natural

What are natural resources?



- A **natural resource** is any natural material that is used by humans.
- Natural resources include air, soil, minerals, water, oil, plants, and animals.
- Earth's natural resources provide everything needed for life, including energy, water, food, and building materials.

How can we categorize natural resources?

- There are many types of natural resources.
- Some can be replaced more quickly than others.
- A natural resource may be categorized as a renewable resource or nonrenewable resource.

How can we categorize natural resources?

- A **renewable resource** is a natural resource that can be replaced at the same rate at which it is consumed.
- Some renewable resources, such as solar energy, are considered *inexhaustible resources* because they can never be used up.
- Other renewable resources are not inexhaustible. Trees and crops, for example, must be replanted and regrown.

How can we categorize natural resources?

- A **nonrenewable resource** is a resource that forms at a rate much slower than the rate at which it is consumed.
- For example, a **fossil fuel** is a nonrenewable resource formed from the buried remains of plants and animals that lived long ago.
- Once a nonrenewable resource is used up, humans will have to find other resources to use instead.



A Material World

How do we use material resources?

- Natural resources that are used to make objects, food, or drink are called **material resources**.
- Material resources can be either renewable or nonrenewable.
- Material resources come from Earth's atmosphere, crust, and waters, and from living organisms.

How do we use material resources?

- All foods and beverages are made from material resources.
- Some foods come from plants, which are renewable because farmers can grow more. Other foods come from animals.
- Various beverages contain water, which is a renewable resource.

How do we use material resources?

- Any object you see is made from material resources.
- Iron, oil, and sand are nonrenewable. If they are used too quickly, they can run out.
- Rubber, leather, and wood are renewable. The plants and animals that produce them can be managed so that these resources do not run out.

Change It Up!

How do we use energy resources?

- Natural resources that are used to generate energy are called **energy resources**.
- Energy is often stored in objects or substances. Stored energy is called *potential energy*.
- For this energy to be useful, it must be converted to *kinetic energy*, which is the energy of movement.

How do everyday objects convert energy?

- Energy cannot be created or destroyed. It must be converted to be useful.
- An electric oven warms food by converting electrical energy to energy as heat.
- Your body converts the chemical energy in food to kinetic energy and thermal energy.

Power Trip

How is electrical energy produced?

- In most electrical power plants, an energy source converts potential energy to kinetic energy, causing wheels in a turbine to spin.
- The spinning wheels cause coils of wire to spin inside a magnet in a generator. The generator converts kinetic energy to electrical energy.
- Different energy resources can provide the energy for a power plant. Examples include moving wind or water, and burning coal or biofuels.

How is electrical energy produced?

- Fuel cells and batteries are other sources of electrical energy.
- A battery has chemicals inside that convert chemical energy to electrical energy.
- Fuel cells convert chemical energy from hydrogen to produce electrical energy.

Clean Machines

- Many car companies are introducing vehicles with hydrogen fuel cells, which use chemical reactions to produce electrical energy.
- The fuel cell removes electrons from hydrogen atoms, and electron movement generates electrical energy.
- Hydrogen then combines with oxygen to form water. The reaction produces water and excess hydrogen, but no pollutants.



Be Resourceful!

What are the two main types of nonrenewable energy resources?

- An **energy resource** is a natural resource that humans use to generate energy, and it can be renewable or nonrenewable.
- *Renewable resources* are replaced by natural processes at least as quickly as they are used.
- *Nonrenewable resources* are used up faster than they can be replaced.

What are the two main types of nonrenewable energy resources?

- A **fossil fuel** is a nonrenewable energy resource that forms from the remains of organisms that lived long ago.
- Fossil fuels release energy when they are burned.
- This energy can be converted to electricity or used to power engines.

What are the two main types of nonrenewable energy resources?

- The energy released when the nuclei of atoms are split or combined is called **nuclear energy**.
- This energy can be obtained by two kinds of nuclear reactions: fusion and fission.
- Today's nuclear power plants use fission, because the technology for fusion power plants does not currently exist.

What are the three main types of fossil fuels?

- Petroleum, or *crude oil*, is a liquid mixture of complex hydrocarbon compounds.
- Crude oil is extracted from the ground by drilling, then processed for use.
- This process, called *refining*, separates the crude oil into different products such as gasoline, kerosene, and diesel fuel.

What are the three main types of fossil fuels?

- Natural gas is a mixture of gaseous hydrocarbons.
- The main component of natural gas is methane. It also contains butane and propane.
- Most natural gas is used for heating and cooking, but some is used to generate electricity, and some is used as fuel for vehicles.

What are the three main types of fossil fuels?

- The fossil fuel most widely used for generating electrical power is coal.
- Coal was once used to heat homes and for transportation.
- Now, however, more than half of our nation's electricity comes from coal-burning power plants.

How do fossil fuels form?

- Petroleum and natural gas form from the remains of tiny sea organisms. The dead organisms sink to the seafloor and are buried by layers of sediment, which become layers of rock.
- Over millions of years, heat and pressure turn the remains of the organisms into petroleum and natural gas.
- The petroleum and natural gas flow into rock that has pores, called *permeable rock*. They are trapped in the rock and form reservoirs.

How do fossil fuels form?

- Coal is formed from the remains of plants. When swamp plants die, they sink to the swamp floor and change to peat, which is then buried by layers of sediment.
- Over time, heat and pressure force water and gases out of the peat. It hardens, its carbon content increases, and it begins changing to coal.
- The amount of heat and pressure determines the type of coal that forms. Lignite forms first, then bituminous coal, and then anthracite.

Power Trip

How are fossil fuels used as energy sources?

- In the United States, petroleum fuels are used mainly for transportation and heating. There are also some oil-fired power plants.
- Natural gas is used mainly for heating and cooking. Some of it is used for transportation, and some as a source for electrical power.
- Coal is used mainly to generate electricity.

How is energy produced from nuclear fuels?

- During **fission**, the nuclei of radioactive atoms are split into two or more fragments.
- A small particle called a neutron hits and splits an atom, releasing large amounts of energy as heat and radiation.
- Fission also releases more neutrons that bombard other atoms. The process repeats as a chain reaction.

How is energy produced from nuclear fuels?

- Inside a reactor core, fuel rods containing uranium provide the material for the chain reaction, and control rods that absorb neutrons regulate the reaction.
- The energy released is used to generate electrical power.
- Radioactivity is contained within the closed reactor system, and nuclear wastes are contained separately for disposal.



CHERNOBYL

The Pros and Cons

How can we evaluate nonrenewable energy resources?

- Nonrenewable resources provide much of the energy that humans need to power transportation, warm homes, and produce electricity relatively cheaply.
- However, the methods of obtaining and using these resources can have negative effects on the environment.

How can we evaluate nonrenewable energy resources?

- Nuclear fission produces a large amount of energy and does not cause air pollution.
- However, nuclear power plants produce dangerous wastes that remain radioactive for thousands of years. The wastes require special storage.
- Harmful radiation may be released into the environment accidentally. Also, the power plant releases hot water that, if not cooled, may disrupt aquatic ecosystems.

How can we evaluate nonrenewable energy resources?

- Fossil fuels are relatively inexpensive to obtain and use, but their use entails some problems.
- Burning coal releases sulfur dioxide, which combines with moisture in the air to produce acid rain. Coal mining disturbs habitats and pollutes water.
- Oil has been associated with occasional oil spills, damaging the environment. Also, burning fossil fuels can cause smog and releases carbon dioxide, a greenhouse gas.

Energy *Déjà Vu*

What are the two main sources of renewable energy?

- An **energy resource** is a natural resource used to generate electricity and other forms of energy.
- Most of the energy used by humans comes from *nonrenewable resources*. These resources are used more quickly than they can be replaced.
- But *renewable resources* can be replaced almost as quickly as they are used. Most of them come from the sun and some from Earth itself.

What are the two main sources of renewable energy?

- The sun's energy is a result of nuclear fusion, a process by which two or more nuclei fuse together to form a larger nucleus.
- Solar energy warms Earth and moves air masses and some ocean currents. It also fuels plant growth. Animals get energy by eating plants.
- Humans can harness energy from wind, moving water, plant and animal materials, and directly from the light and heat coming from the sun.

What are the two main sources of renewable energy?

- One source of energy from within Earth is the decay of radioactive elements in Earth's mantle and crust, caused by nuclear fission.
- The second source of energy within Earth is energy stored during Earth's formation.
- The heat produced from these sources radiates outward toward Earth's surface. Humans can harness this heat to use as an energy source.

How might a renewable energy resource become nonrenewable?

- Trees are a renewable resource.
- However, some forests are being cut down but are not being replanted in a timely manner. Others are being cut down and replaced with buildings.
- If this process continues, eventually these forests will no longer be considered renewable resources.

Turn, Turn, Turn

How do humans use wind energy?

- **Wind energy** uses the force of moving air to drive an electric generator or do other work.
- Wind energy is renewable because the wind will blow as long as the sun warms Earth.
- Wind energy is harnessed by machines called wind turbines. Clusters of wind turbines, called wind farms, generate large amounts of electricity.

How do humans use wind energy?

- Wind energy has several disadvantages. Wind farms can be placed only in areas that receive large amounts of wind.
- Production and maintenance of the equipment is expensive and produces some pollution.
- The turbine blades can be hazardous to birds.

How do humans get energy from moving water?

- Moving water has kinetic energy.
- Electrical energy produced by moving water is called **hydroelectric energy**. It is renewable because the water cycle is driven by the sun.
- The energy in flowing water is converted to electrical energy when it spins turbines connected to electric generators inside a dam.

How do humans get energy from moving water?

- Hydroelectric energy is a good source of energy only in locations where there are large, reliable amounts of flowing water.
- Another disadvantage is that hydroelectric dams and their technology are expensive to build.
- Dams can block the movement of fish between the sea and their spawning grounds, and special ladders must be built to allow fish to swim around the dam.

Let the Sunshine In

How do humans use solar energy?

- **Solar energy** is the energy received by Earth from the sun in the form of radiation.
- Solar energy can be used to warm buildings directly.
- It can also be converted into electricity by solar cells.

How do humans use solar energy?

- We can use liquids warmed by the sun to warm water and buildings.
- When heat is absorbed by liquid in a solar collector, it can be transferred to water that can be used to warm the building or for various household purposes.
- The only pollution generated by solar heating systems comes from the manufacture and maintenance of the equipment.

How do humans use solar energy?

- Solar collectors can be used to heat fluid and produce steam. The steam then turns a turbine connected to a generator that produces electricity.
- Electricity can also be generated when sunlight is absorbed by a photovoltaic cell. Many cells must be joined together to form a solar panel.
- Solar power plants must be built in places with adequate space and abundant sunshine year-round.

How do humans get energy from living things?

- **Biomass** is organic matter from plants and from animal waste that contains chemical energy. It can be burned to release energy.
- Biomass is inexpensive and can usually be replaced relatively quickly, so it is considered to be a renewable resource.
- Like fossil fuels, biomass produces pollutants when burned.

How do humans get energy from living things?

- Biomass material can be used to produce an alcohol called ethanol.
- The sugars or cellulose in plants are eaten by microbes, which give off carbon dioxide and ethanol.
- The ethanol is collected and burned as a fuel, or it can be mixed with gasoline to make a fuel called gasohol.

How do humans use geothermal energy?

- **Geothermal energy** is produced by heat from Earth's interior. This energy heats rock formations deep within the ground.
- Groundwater absorbs this heat and forms hot springs and geysers where the water reaches Earth's surface.
- Geothermal energy is used to produce energy as heat and electricity.

How do humans use geothermal energy?

- Geothermal energy is used to warm and cool buildings.
- Water is pumped through a closed loop of pipes that runs from underground into a building's heating system. The water absorbs heat from the ground and warms the building.
- In warmer months, the ground is cooler than the air, so this system can also be used for cooling.

How do humans use geothermal energy?

- Geothermal energy is also used to produce electricity.
- Wells are drilled into areas of superheated groundwater. Geothermal power plants use the escaping steam or hot water to spin turbines and generate electricity.
- However, production of the equipment generates pollution, and the technology is expensive to make and maintain.

Useful Stuff

What are the two main types of resources?

- Any natural material that is used by people is a **natural resource**.
- Resources can be divided into renewable and nonrenewable resources.

What are the two main types of resources?

- A natural resource that can be replaced as quickly as the resource is used is a **renewable resource**.
- Water, trees, and fish are examples of renewable resources.
- Renewable resources can become nonrenewable resources if they are used too quickly.

What are the two main types of resources?

- A natural resource that is used much faster than it can be replaced is a **nonrenewable resource**.
- Coal, minerals, oil, and natural gas are examples of nonrenewable resources.

What can happen when we use resources?

- Natural resources allow us to heat and cool buildings, produce and use electricity, transport people and goods, and make products.
- However, mining and oil spills can damage ecosystems, and burning fossil fuels generates pollutants. Used products can fill landfills or litter beaches.
- Overuse of resources can make them hard to find and more expensive.

Best Practices



What are some effective ways to manage resources?

- People can ensure that resources continue to be available by practicing stewardship and conservation.
- **Stewardship** is the careful and responsible management of resources.
- **Conservation** is the protection and wise use of natural resources.

What are some effective ways to manage resources?

- Stewardship of renewable resources involves various conservation practices.
- Limits on fishing or logging can increase fish populations and protect forest ecosystems.
- Water conservation can reduce the amount of water used, so that rain can renew the water supply. Reducing the use of chemicals and energy resources can reduce pollutants.

What are some effective ways to manage resources?

- Nonrenewable resources last longer if used efficiently.
- By using less electrical energy, fewer resources like coal are needed to produce electricity.
- Reducing, reusing, and recycling also reduce the amount of natural resources that must be obtained from Earth.

Pluses and Minuses

What are the disadvantages and advantages of managing resources?

- Managing resources has disadvantages. Developing new technologies that use fewer resources is expensive.
- Changing how people use resources can be difficult, because some people have a hard time breaking old habits.
- Recycling resources can sometimes be expensive and inconvenient.

What are the disadvantages and advantages of managing resources?

- Managing resources also has many advantages.
- Management can reduce the loss of a valuable resource. It can also reduce waste, thus requiring less space in landfills.
- Many resources produce pollution as they are gathered or used, so resource management can lead to less pollution.

What kinds of changes can we make to manage resources?

- Managing natural resources takes place on global, national, state, local, and individual levels.
- On the global level, countries make agreements to help manage international resources.
- For example, countries agreed to stop using chemicals called CFCs that were found to damage the ozone layer.

What kinds of changes can we make to manage resources?

- On the national level, countries pass laws to manage resources.
- Laws also govern how materials must be disposed of to prevent and reduce harm to land and water.
- Government funding promotes recycling programs and allows scientists to develop technologies for using resources more efficiently.

What kinds of changes can we make to manage resources?

- Changing some of your habits can help conserve resources.
- For example, conserve water by taking shorter showers. Recycle disposable materials instead of throwing them away.
- Save energy by turning off lights or TV sets when not in use. Families can buy energy-efficient appliances.