

Teacher Background Information

What is Non-renewable Energy?

Non-renewable energy comes from sources that will run out or will not be replenished in our lifetimes—or even in many, many lifetimes.

Fossil Fuels

Most non-renewable energy sources are fossil fuels: coal, petroleum, and natural gas. When ancient organisms died, they drifted to the bottom of the sea or lake. There was energy stored in the plants and animals when they died.

High heat and pressure underground turned them into fossil fuels (coal, natural gas, and petroleum).

Advantages and Disadvantages of Fossil Fuels

Fossil fuels are a valuable source of energy. They are relatively inexpensive to extract. They can also be stored, piped, or shipped anywhere in the world.

However, burning fossil fuels is harmful for the environment. When coal and oil are burned, they release particles that can pollute the air, water, and land.

The carbon in fossil fuels has been sequestered, or stored, underground for millions of years. By removing this sequestered carbon from the earth and releasing it into the atmosphere, Earth's carbon budget is out of balance. This contributes to temperatures rising faster than organisms can adapt.

Coal

Coal is a black or brownish rock. We burn coal to create energy. Peat is the lowest rank of coal. It is an important fuel in areas of the world including Scotland, Ireland, and Finland. Anthracite is the highest rank of coal. Anthracite forms in regions of the world where there have been giant movements of the earth, such as the formation of mountain ranges. The Appalachian Mountains, in the eastern part of the United States, are rich in anthracite.

There are two ways that we can mine coal: underground mining and surface mining. Underground mining is used when the coal is located below the surface of the Earth, sometimes 300 meters (1,000 feet) deep. Miners operate heavy machinery that cuts the coal out of the Earth and brings it above ground. This can be dangerous work because cutting coal can release dangerous gases. The gases can cause explosions or make it hard for miners to breathe. Surface mining is used when the coal is located very near the surface of the earth. To get to the coal, companies must first clear the area of trees and soil. The coal can then be cut out of the ground more easily. Entire habitats can be destroyed.

Remember the three fossil fuels are:

coal



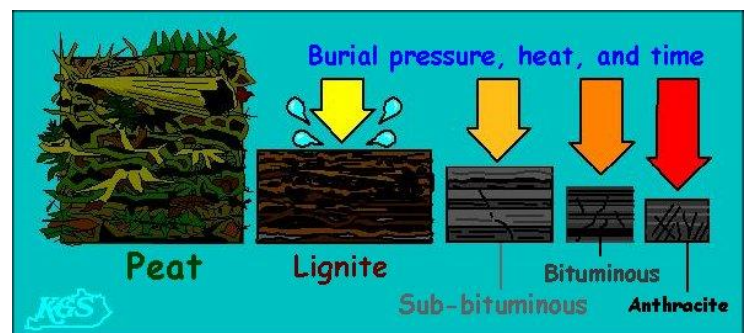
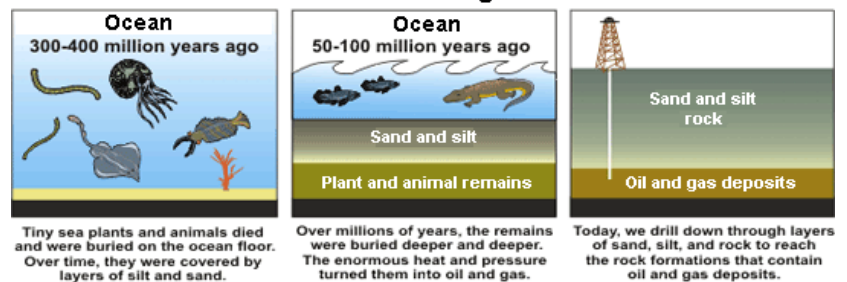
crude oil



natural gas



Petroleum and natural gas formation



About half the electricity in the United States comes from coal. When coal is burned, it leaves “byproducts” that are also valuable. We use the byproducts to make cement, plastics, roads, and many other things.

Advantages and Disadvantages of Coal

Coal is a reliable source of energy. Using coal is also harmful. Mining is one of the most dangerous jobs in the world. Coal miners are exposed to toxic dust and face the dangers of cave-ins and explosions at work. When coal is burned, it releases many toxic gases and pollutants into the atmosphere. Mining for coal can also cause the ground to cave in and create underground fires that burn for decades at a time.

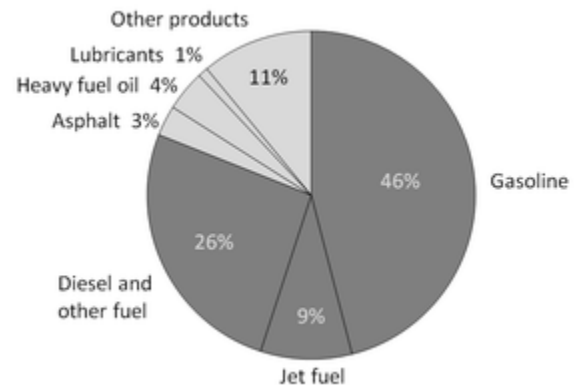
Petroleum

Petroleum is a liquid fossil fuel. It is also called oil or crude oil. Petroleum is trapped by underground rock formations. In some places, oil bubbles right out of the ground.

Most of the world’s oil is still deep under the ground. We drill through the earth to access the oil. Some deposits are on land, and others are under the ocean floor. Once oil companies begin drilling with a “drill rig,” they can extract petroleum 24 hours a day, seven days a week, 365 days a year. Many successful oil sites produce oil for about 30 years. Sometimes they can produce oil for much longer. When oil is under the ocean floor, companies drill offshore. They must build an oil platform.

Once the oil has been drilled, it must be refined. Oil contains many chemicals besides carbon, and refining the oil takes some of these chemicals out.

We use oil for many things. About half of the world’s petroleum is converted into gasoline. The rest can be processed and used in liquid products such as nail polish and rubbing alcohol, or solid products such as water pipes, shoes, crayons, roofing, vitamin capsules, and thousands of other items.



Advantages and Disadvantages of Petroleum

There are advantages to drilling for oil. It is relatively inexpensive to extract. It is also a reliable and dependable source of energy and money for the local community. Oil provides us with thousands of conveniences. In the form of gasoline, it is a portable source of energy that gives us the power to drive places. Petroleum is also an ingredient in many items that we depend on.

However, burning gasoline is harmful to the environment. It releases hazardous gases and fumes into the air that we breathe. There is also the possibility of an oil spill. If there is a problem with the drilling machinery, the oil can explode out of the well and spill into the ocean or surrounding land. Oil spills are environmental disasters, especially offshore spills. Oil floats on water, so it can look like food to fish and ruin birds’ feathers.

Natural Gas

Natural gas is another fossil fuel that is trapped underground in reservoirs. It is mostly made up of methane. You may have smelled methane before. The decomposing material in landfills also release methane (its actual odorless, but often is mixed with gases like H₂S), which smells like rotten eggs.

Natural gas is found in deposits a few hundred meters underground. In order to get natural gas out of the ground, companies drill straight down. Natural gas is trapped in rock formations that can stretch for kilometers. To reach natural gas, some companies use a process called “hydraulic fracturing,” or fracking. Hydraulic means they use water, and fracturing means to “split apart.” The process uses high-pressure water to split apart the rocks underground. This

releases the natural gas that is trapped in rock formations. If the rock is too hard, they can send acid down the well to dissolve the rock. They can also use tiny grains of glass or sand to prop open the rock and let the gas escape.

We use natural gas for heating and cooking. Natural gas can also be burned to generate electricity. We rely on natural gas to power our homes. Natural gas can also be turned into a liquid form, called liquid natural gas (LNG). LNG is much cleaner than any other fossil fuels. Liquid natural gas takes up much less space than the gaseous form. LNG can be easily stored and used for different purposes. LNG can even be a replacement for gasoline.

Advantages and Disadvantages of Natural Gas

Natural gas is relatively inexpensive to extract, and is a “cleaner” fossil fuel than oil or coal. When natural gas is burned, it only releases carbon dioxide and water vapor.

However, extracting natural gas can cause environmental problems. Fracturing rocks can cause mini-earthquakes. The high-pressure water and chemicals that are forced underground can also leak to other sources of water. The water sources, used for drinking or bathing, can become contaminated and unsafe.

Other Non-renewable Energy Sources

Fossil fuels are the leading non-renewable energy sources around the world. There are others, however.

Nuclear Energy

Nuclear energy is usually considered another non-renewable energy source. Although nuclear energy itself is a renewable energy source, the material used in nuclear power plants is not.

Nuclear energy harvests the powerful energy in the nucleus, or core, of an atom. Nuclear energy is released through nuclear fission, the process where the nucleus of an atom splits. Nuclear power plants are complex machines that can control nuclear fission to produce electricity. The material most often used in nuclear power plants is the element uranium. Although uranium is found in rocks all over the world, nuclear power plants usually use a very rare type of uranium, U-235. Uranium is a non-renewable resource.

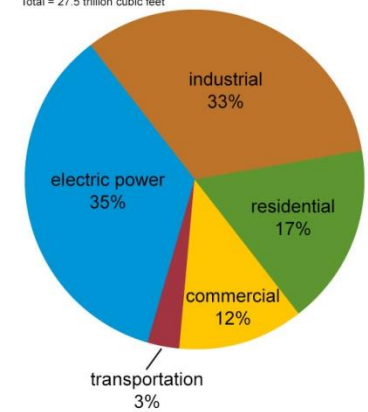
Advantages and Disadvantages of Nuclear Energy

Nuclear energy is a popular way of generating electricity around the world. Nuclear power plants do not pollute the air or emit greenhouse gases. They can be built in rural or urban areas, and do not destroy the environment around them.

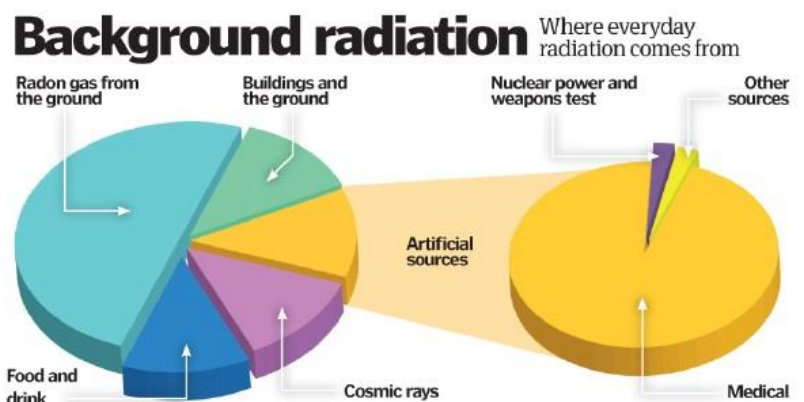
However, nuclear energy is difficult to harvest. Nuclear power plants are very complicated to build and run. Many communities do not have the scientists and engineers to develop a safe and reliable nuclear energy program. Nuclear energy also produces radioactive material. Radioactive waste can be extremely toxic, causing burns and increasing the risk for cancers, blood diseases, and bone decay among people who are exposed to it.

U.S. natural gas consumption by sector, 2015

Total = 27.5 trillion cubic feet



Source: U.S. Energy Information Administration, *Monthly Energy Review*, April 2016, preliminary data

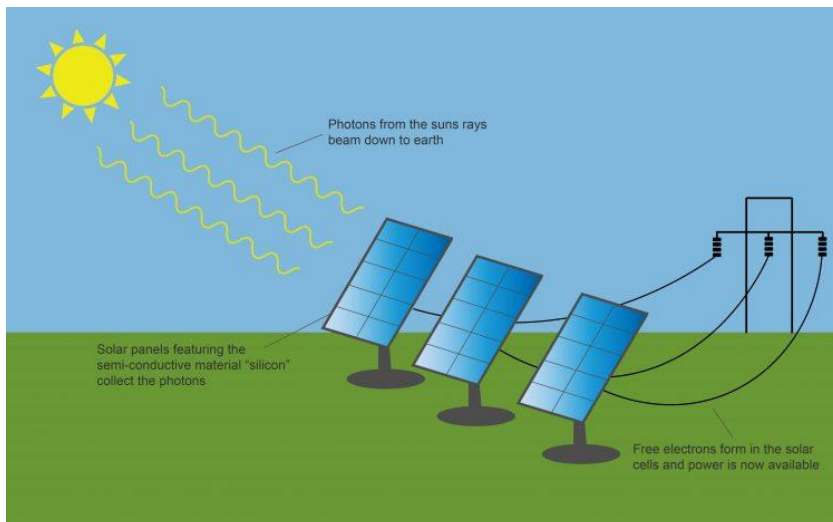


What is Renewable Energy?

The wind, the sun, and Earth are sources of renewable energy. These energy sources naturally renew, or replenish themselves.

Solar Energy

Solar energy can be captured “actively” or “passively.” Active solar energy uses special technology to capture the sun’s rays. The two main types of equipment are photovoltaic cells (also called PV cells or solar cells) and mirrors that focus sunlight in a specific spot. These active solar technologies use sunlight to generate electricity, which we use to power lights, heating systems, computers and televisions. Passive solar energy does not use any equipment. Instead, it gets energy from the way sunlight naturally changes throughout the day. For example, people can build houses so their windows face the path of the sun. This means the house will get more heat from the sun. It will take less energy from other sources to heat the house. Other examples of passive solar technology are green roofs, cool roofs, and radiant barriers. Green roofs are completely covered with plants. Plants can get rid of pollutants in rainwater and air. They help make the local environment cleaner. Cool roofs are painted white. Radiant barriers are made of a reflective covering, such as aluminum. They both reflect the sun’s heat instead of absorbing it. All these types of roofs help lower the amount of energy needed to cool the building.



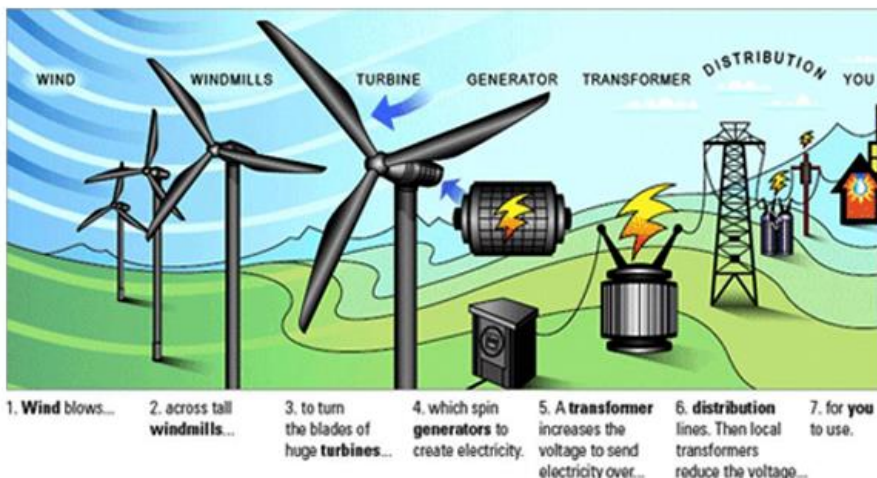
Advantages and Disadvantages

There are many advantages to using solar energy. PV cells last for a long time, about 20 years. However, there are reasons why solar power cannot be used as the only power source in a community. It can be expensive to install PV cells or build a building using passive solar technology. Sunshine can also be hard to predict. It can be blocked by clouds, and the sun doesn't shine at night. Different parts of Earth receive different amounts of sunlight based on location, the time of year, and the time of day.

Wind Energy

People have been harnessing the wind's energy for a long, long time. Five thousand years ago, ancient Egyptians made boats powered by the wind. In 200 BCE, people used windmills to grind grain in the Middle East and pump water in China.

Today, we capture the wind's energy with wind turbines. A turbine is similar to a windmill; it has a very tall tower with two or three propeller-like blades at the top. These blades are turned by the wind. The blades turn a generator (located inside the tower), which creates electricity. Groups of wind turbines are known as wind farms. Wind farms can be found near farmland, in narrow mountain passes, and even in the ocean, where there are steadier and stronger winds. Wind turbines anchored in the ocean are called “offshore wind farms.” Wind farms create electricity for nearby homes, schools, and other buildings.



Advantages and Disadvantages

Wind energy can be very efficient. In places like the Midwest and along coasts, steady winds can provide cheap, reliable electricity. Another great advantage of wind power is that it is a “clean” form of energy. Wind turbines do not burn fuel or emit any pollutants into the air.

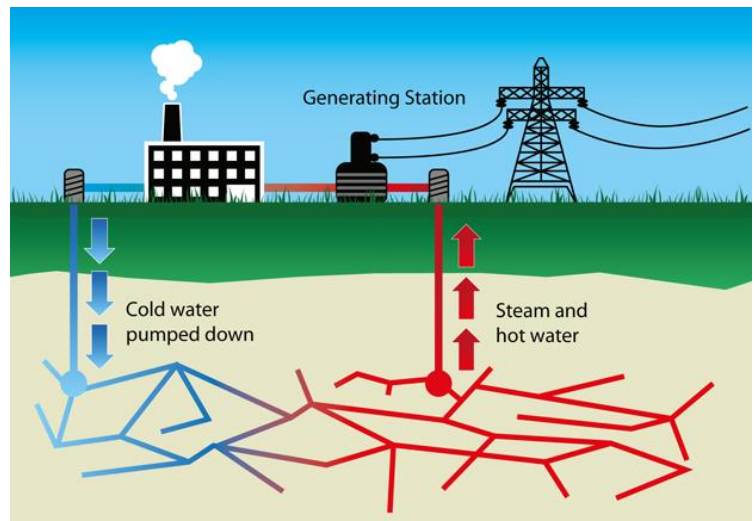
Wind is not always a steady source of energy, however. Wind speed changes constantly, depending on the time of day, weather, and geographic location. Currently, it cannot be used to provide electricity for all our power needs. Wind turbines can be also dangerous for bats and birds. These animals cannot always judge how fast the blades are moving and crash into them.

Geothermal Energy

Deep beneath the surface of the Earth is the Earth’s core. The center of the Earth is extremely hot—thought to be over 5,000 °C (about 9,000 °F). The heat is constantly moving toward the surface. We can see some of the Earth’s heat when it bubbles to the surface. Geothermal energy can melt underground rocks into magma and cause the magma to bubble to the surface as lava. Geothermal energy can also heat underground sources of water and force it to spew out from the surface. This stream of water is called a geyser. However, most of the Earth’s heat stays underground and makes its way out very, very slowly.

We can access underground geothermal heat in different ways. One way of using geothermal energy is with “geothermal heat pumps.” A pipe of water loops between a building and holes dug deep underground. The water is warmed by the geothermal energy underground and brings the warmth aboveground to the building. Geothermal heat pumps can be used to heat houses, sidewalks, and even parking lots.

Another way to use geothermal energy is with steam. In some areas of the world, there is underground steam that naturally rises to the surface. The steam can be piped straight to a power plant. However, in other parts of the world, the ground is dry. Water must be injected underground to create steam. When the steam comes to the surface, it is used to turn a generator and create electricity. In Iceland, there are large reservoirs of underground water. Almost 90% of people in Iceland use geothermal as an energy source to heat their homes and businesses.



Advantages and Disadvantages

An advantage of geothermal energy is that it is clean. It does not require any fuel or emit any harmful pollutants into the air. A disadvantage of using geothermal energy is that in areas of the world where there is only dry heat underground, large quantities of freshwater are used to make steam. There may not be a lot of freshwater. People need water for drinking, cooking, and bathing.

Biomass Energy

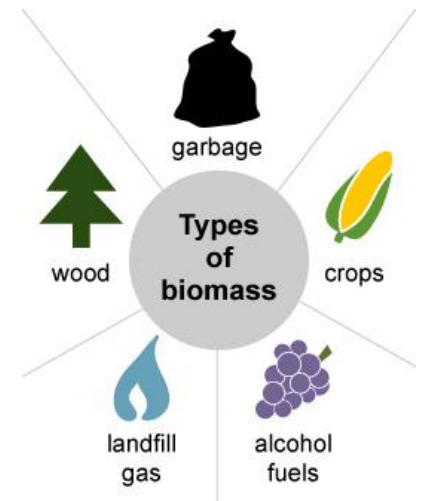
Biomass is any material that comes from plants or microorganisms that were recently living. Plants create energy from the sun through photosynthesis. This energy is stored in the plants even after they die. Trees, branches, scraps of bark, and recycled paper are common sources of biomass energy. Manure, garbage, and crops such as corn, soy, and sugar cane can also be used as biomass feedstocks.

We get energy from biomass by burning it. Wood chips, manure, and garbage are dried out and compressed into squares called “briquettes.” These briquettes are so dry that they do not absorb water. They can be stored and burned to create heat or generate electricity. Biomass can also be converted into biofuel. Biofuels are mixed with regular gasoline and can be used to power cars and trucks. Biofuels release less harmful pollutants than pure gasoline.

Advantages and Disadvantages

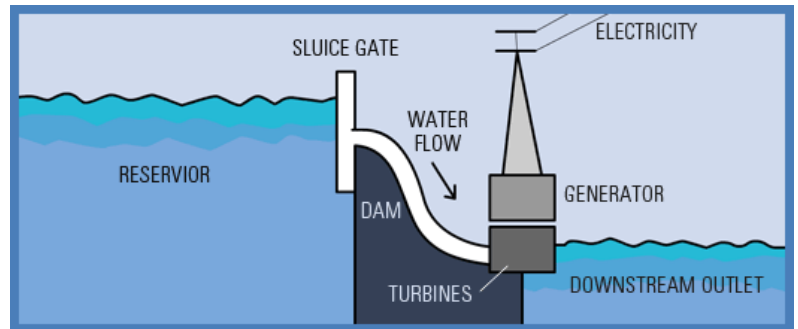
A major advantage of biomass is that it can be stored and used when it is needed. Growing crops for biofuels, however, requires large amounts of land and pesticides. Land could be used for food instead of biofuels. Some pesticides could pollute the air and water.

Biomass energy can also be a non-renewable energy source. Biomass energy relies on biomass feedstocks—plants that are processed and burned to create electricity. Biomass feedstocks can include crops such as corn or soy, as well as wood. If people do not replant biomass feedstocks as fast as they use them, biomass energy becomes a non-renewable energy source.



Hydroelectric Energy

Hydroelectric energy is made by flowing water. Most hydroelectric power plants are located on large dams, which control the flow of a river. Dams block the river and create an artificial lake, or reservoir. A controlled amount of water is forced through tunnels in the dam. As water flows through the tunnels, it turns huge turbines and generates electricity.



Advantages and Disadvantages

Hydroelectric energy is fairly inexpensive to harness. Hydroelectric energy is also fairly reliable. Engineers control the flow of water through the dam, so the flow does not depend on the weather (the way solar and wind energies do).

However, hydroelectric power plants are damaging to the environment. When a river is dammed, it creates a large lake behind the dam. This lake (sometimes called a reservoir) drowns the original river habitat deep underwater. Sometimes, people build dams that can drown entire towns underwater. The people who live in the town or village must move to a new area. Hydroelectric power plants don't work for a very long time: Some can only supply power for 20 or 30 years. Silt, or dirt from a riverbed, builds up behind the dam and slows the flow of water.

Other Renewable Energy Sources

Scientists and engineers are constantly working to harness other renewable energy sources. Three of the most promising are tidal energy, wave energy, and algal (or algae) fuel.

Tidal energy harnesses the power of ocean tides to generate electricity. Some tidal energy projects use the moving tides to turn the blades of a turbine. Other projects use small dams to continually fill reservoirs at high tide and slowly release the water (and turn turbines) at low tide.

Wave energy harnesses waves from the ocean, lakes, or rivers. Some wave energy projects use the same equipment that tidal energy projects do—dams and standing turbines. Other wave energy projects float directly on waves. The water's constant movement over and through these floating pieces of equipment turns turbines and creates electricity.

Algal fuel is a type of biomass energy that uses the unique chemicals in seaweed to create a clean and renewable biofuel. Algal fuel does not need the acres of cropland that other biofuel feedstocks do.

Human Impacts on Natural Resources

Over six billion people live on planet Earth. As the population grows, we are taking more and more land to live and using more of the world's natural resources. Many human activities also produce pollution, which is damaging the Earth's environment.

How Does Farming Change The Landscape?

since farming began, 10,000 years ago, many wild landscapes have been transformed to create fields for crops and raising animals. Swamps and coastal marshes have been drained. Forests have been felled and grasslands have been plowed. However, removing tree and plant roots that help to bind the soil can make the soil loose and crumbly. High winds may then blow it away, or heavy rain may wash it into rivers. In some areas, soil erosion has turned fertile farmland into barren wastes.

How Does Industry Affect The Landscape?

In the 1700s, the dawn of the industrial age revolutionized methods of manufacturing and made them more efficient. Since then, factories have been built all over the world. Factories consume huge amounts of natural resources and energy, and many give off chemical waste, which creates problems such as air and water pollution, and global warming.

What Challenges Face The Human Population?

One of our main challenges is to find the right balance between using and conserving Earth's natural resources. The human species dominates Earth in a way that no species has done before. Our demands for fuel, water, land, and food are beginning to place a strain on the planet's limited resources. What makes us different from other species, however, is our ability to recognize these global problems and our inventiveness in doing something about them.

Pollution

All over the world, factories, power plants, farms, businesses, and homes produce huge amounts of pollution by releasing chemicals and other substances that pollute, or dirty, the natural environment. As people's use of energy and other resources grows, the Earth is becoming more polluted.

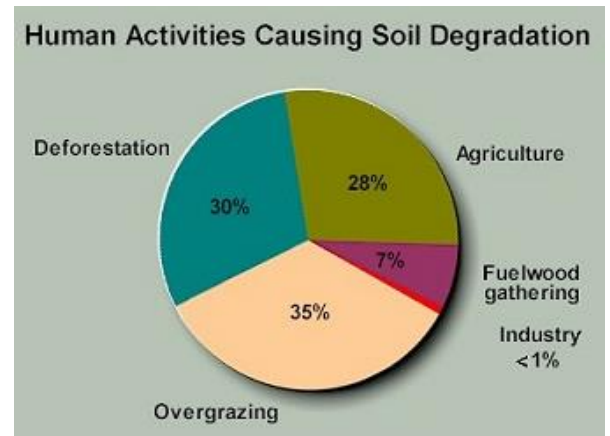
What Are The Main Causes Of Pollution?

Industrial waste, sewage, and chemical pesticides from farms seep into streams and rivers. Cars, factories, and power plants burning fossil fuels give off fumes that pollute the air. Chemicals called cfc's (short for chlorofluorocarbons), used to make refrigerators and aerosol sprays, destroy the ozone layer, which protects us from harmful sunlight. Household and other waste buried underground pollutes the land.

How Long Does Pollution Last?

Some kinds of pollution quickly disperse on the wind or are diluted by water. Other types, such as radioactive waste, stay poisonous for thousands of years. Plastics and other domestic garbage that are buried underground in landfill sites may take many years to rot away completely.

What Can Be Done To Reduce Pollution?



Around the world, scientists are investigating the damage caused by pollution. Governments have introduced controls that curb the pollution produced by industry and farms, and restrict the development of land, especially in rural areas. Everyone can help to reduce pollution by using energy carefully, and by recycling glass bottles, cans, plastic, and paper so that they can be reused. This helps to save precious natural resources and cuts down on waste and litter.

Global Warming

Global warming is the slow and steady rise in Earth's temperature caused by a buildup of "greenhouse gases" in the air due to pollution. Some experts predict temperatures will rise by 2.5–8.1°F (1.4–4.5°C) this century.

What Is Causing Global Warming?

Global warming is caused by the increased level of carbon dioxide and other greenhouse gases in the atmosphere. These gases are released from car exhausts and when fossil fuels are burned in factories and power plants. Greenhouse gases also include cfc's from aerosols and old refrigerators, and methane from swamps, gas pipes, and rotting garbage.

How Will Global Warming Affect Everyday Life?

Global warming will melt some of the polar ice caps, bringing greater risk of floods to low-lying and coastal regions worldwide. Heat waves, droughts, hurricanes, and torrential rain will become more common. To prevent global warming, many countries are now trying to reduce their output of carbon dioxide and use renewable energy sources.

Sources:

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