

# Nonrenewable Energy Resources

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Printed: October 30, 2016

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## CHAPTER

## 1

# Nonrenewable Energy Resources

## Learning Objectives

## Lesson Objectives

- Describe how fossil fuels are formed.
- Describe different fossil fuels, and understand why they are non-renewable resources.
- Explain how fossil fuels are turned into useful forms of energy.
- Understand that when we burn a fossil fuel, most of its energy is released as heat.
- Describe how the use of fossil fuels affects the environment.

## Vocabulary

- hydrocarbons

## Introduction

Have you ever seen dinosaur fossils at a museum? The same processes that formed dinosaur fossils created fossil fuels. Fossil fuels are now our most important energy resources. Most of the energy we use for industry comes from them. Most energy to heat and cool homes and to get us around does, too. Fossil fuels provide high-quality energy. But the use of fossil fuels has consequences. Burning fossil fuel releases pollutants, including greenhouse gases. Also, we are using up these resources much faster than they can be replaced.

## Formation of Fossil Fuels

Fossil fuels are made from plants and animals that lived hundreds of millions of years ago. The plants and animals died. Their remains settled onto the ground and at the bottom of the sea. Layer upon layer of organic material was laid down. Eventually, the layers were buried very deeply. They experienced intense heat and pressure. Over millions of years, the organic material turned into fossil fuels.

Fossil fuels are compounds of carbon and hydrogen, called **hydrocarbons**. Hydrocarbons can be solid, liquid, or gas. The solid form is coal. The liquid form is petroleum, or crude oil. The gaseous form is natural gas.

## Coal

Coal is a solid hydrocarbon. Coal is useful as a fuel, especially for generating electricity.

## How Coal Forms

Coal forms from dead plants that settled at the bottom of swamps millions of years ago. Water and mud in the swamp kept oxygen away from the plant material. Sand and clay settled on top of the decaying plants. The weight of this material squeezed out the water and some other substances. Over time, the organic material became a carbon-rich rock. This rock is coal.

## What Coal Is

Coal is a black or brownish-black rock that burns easily (**Figure 1.1**). Most coal is sedimentary rock. The hardest type of coal, anthracite, is a metamorphic rock. That is because it is exposed to higher temperature and pressure as it forms. Coal is mostly carbon, but some other elements can be found in coal, including sulfur.



**FIGURE 1.1**

Coal is a solid hydrocarbon formed from decaying plant material over millions of years.

## Mining Coal

Around the world, coal is the largest source of energy for electricity. The United States is rich in coal. Pennsylvania and the region to the west of the Appalachian Mountains are some of the most coal-rich areas of the United States.

Coal has to be mined to get it out of the ground. Coal mining affects the environment and human health. Coal mining can take place underground or at the surface. Each method has some advantages and disadvantages.

- Surface mining exposes minerals that were underground to air and water at the surface. These minerals contain the chemical element sulfur. Sulfur mixes with air and water to make sulfuric acid. This acid is a highly corrosive chemical. Sulfuric acid gets into nearby streams and can kill fish, plants, and animals. Surface mining is safer for the miners.
- Coal mining underground is dangerous for the coal miners. Miners are sometimes killed if there is an explosion or a mine collapse. Miners breathe in coal dust and can get terrible lung diseases after a number of years in the mines.

## Using Coal

To prepare coal for use, the coal is first crushed into powder and burned in a furnace. Like other fuels, coal releases most of its energy as heat when it burns. The heat from the burning coal is used to boil water. This makes steam. The steam spins turbines, which creates electricity.

## Oil

Oil is a thick, dark brown or black liquid. It is found in rock layers of the Earth's crust. Oil is currently the most commonly used source of energy in the world.

## How Oil Forms

The way oil forms is similar in many ways to coal. Tiny organisms like plankton and algae die and settle to the bottom of the sea. Sediments settle over the organic material. Oxygen is kept away by the sediments. When the material is buried deep enough, it is exposed to high heat and pressure. Over millions of years, the organic material transforms into liquid oil.

## Mining Oil

The United States produces only about one-quarter as much oil as it uses. The main oil producing regions in the U.S. are the Gulf of Mexico, Texas, Alaska, and California.

Geologists look for oil in folded layers of rock called anticlines. Oil moves through permeable rock and is trapped by the impermeable cap rock.



**FIGURE 1.2**

This oil refinery processes crude oil into usable energy sources, such as gasoline.

## Types of Oil

Oil comes out of the ground as crude oil. Crude oil is a mixture of many different hydrocarbons. Oil is separated into different compounds at an oil refinery (**Figure 1.2**). This is done by heating the oil. Each hydrocarbon compound in crude oil boils at a different temperature. We get gasoline, diesel, and heating oil, plus waxes, plastics, and fertilizers from crude oil.

These fuels are rich sources of energy. Since they are mostly liquids they can be easily transported. These fuels provide about 90% of the energy used for transportation around the world.

## Gasoline

Gasoline is a concentrated resource. It contains a large amount of energy for its weight. This is important because the more something weighs, the more energy is needed to move it. If gasoline could only provide a little energy, a car would have to carry a lot of it to be able to travel very far. Or the car would need to be filled up frequently. So a highly concentrated energy resource is a practical fuel to power cars and other forms of transportation.

Let's consider how gasoline powers a car. As gasoline burns, it releases most of its energy as heat. It also releases carbon dioxide gas and water vapor. The heat makes the gases expand. This forces the pistons inside the engine to move. The engine makes enough power to move the car.

## Using Oil

Using gasoline to power automobiles affects the environment. The exhaust fumes from burning gasoline cause air pollution. These pollutants include smog and ground-level ozone. Air pollution is a big problem for cities where

large numbers of people drive every day. Burning gasoline also produces carbon dioxide. This is a greenhouse gas and is a cause of global warming. Similar pollutants come from other forms of oil.

## Natural Gas

Natural gas is mostly methane.

### How Natural Gas Forms

Natural gas is often found along with coal or oil in underground deposits. This is because natural gas forms with these other fossil fuels. One difference between natural gas and oil is that natural gas forms at higher temperatures.

### Natural Gas Use

The largest natural gas reserves in the United States are located in the Rocky Mountain states, Texas, and the Gulf of Mexico region. California also has natural gas, mostly in the northern Sacramento Valley and the Sacramento Delta.

Natural gas must be processed before it can be used as a fuel. Poisonous chemicals and water must be removed.

Natural gas is delivered to homes, where it is used for cooking and heating. Natural gas is also a major energy source for powering turbines to make electricity. Natural gas releases most of its energy as heat when it burns. The power plant is able to use this heat, either in the form of hot gases or steam, to spin turbines. The spinning turbines turn generators, and the generators create electricity.

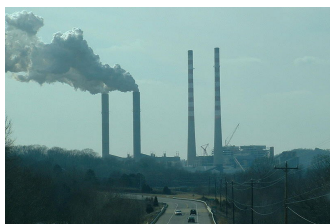
### Consequences of Natural Gas Use

Processing natural gas has harmful effects on the environment, just like oil. Natural gas burns cleaner than other fossil fuels. As a result, it causes less air pollution. It also produces less carbon dioxide than the other fossil fuels. Still, natural gas does emit pollutants.

## Problems with Fossil Fuels

Fossil fuels present many problems. These fuels are non-renewable resources, so our supplies of them will eventually run out. Safety can be a problem, too. Since these fuels burn so easily, a natural gas leak in a building or an underground pipe can lead to a deadly explosion.

Using fossil fuels affects the environment in a variety of ways. There are impacts to the environment when we extract these resources. Burning these fuels causes air pollution. These fuels release carbon dioxide, which is a major factor in global warming (**Figure 1.3**).



**FIGURE 1.3**

Burning fossil fuels releases pollutants into the air.

Many of the problems with fossil fuels are worse for coal than for oil or natural gas. Burning coal releases more carbon dioxide than either oil or natural gas. Yet coal is the most common fossil fuel, so we continue to burn large amounts of it. That makes coal the biggest contributor to global warming.

Another problem with coal is that most coal contains sulfur. As it burns, the sulfur goes into the air as sulfur dioxide. Sulfur dioxide is the main cause of acid rain. Acid rain can be deadly to plants, animals, and whole ecosystems. Burning coal also puts a large number of small solid particulates into the air. These particles are dangerous to people, especially those who have asthma. People with asthma may end up in the hospital on days when particulate pollution is high.

## Nuclear Energy

Nuclear energy is produced by splitting the nucleus of an atom. This releases a huge amount of energy.

### How Nuclear Power Plants Work

Nuclear power plants use uranium that has been concentrated in fuel rods (**Figure 1.4**). The uranium atoms are split apart when they are hit by other extremely tiny particles. These particles must be controlled or they would cause a dangerous explosion.



**FIGURE 1.4**

Nuclear power plants like this one provide France with almost 80% of its electricity.

Nuclear power plants use the energy they produce to heat water. The water turns into steam, which causes a turbine to spin. This in turn produces electricity.

### Nuclear Power and a Resource

Many countries around the world use nuclear energy as a source of electricity. For example, France gets about 80% of its electricity from nuclear energy. In the United States, a little less than 20% of electricity comes from nuclear energy.

Nuclear energy does not pollute. If there are no accidents, a nuclear power plant releases nothing but steam into the air. But nuclear energy does create other environmental problems. Splitting atoms creates dangerous radioactive

waste. These wastes can remain dangerous for hundreds of thousands of years. Scientists and engineers are still looking for ways to keep this waste safely away from people.

### KQED: Nuclear Energy Use

Nuclear power is a controversial subject in California and most other places. Nuclear power has no pollutants including carbon emissions, but power plants are not always safe and the long-term disposal of wastes is a problem that has not yet been solved. The future of nuclear power is murky. Find out more at: <http://science.kqed.org/questions/audio/new-nuclear/>



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### Lesson Summary

- Coal, oil and natural gas are all fossil fuels formed from the remains of once living organisms.
- Coal is our largest source of energy for producing electricity.
- Mining and using coal produce many environmental impacts, including carbon dioxide emissions and acid rain.
- Oil and natural gas are important sources of energy for many types of vehicles and uses in our homes and industry.
- Fossil fuels are non-renewable sources of energy that produce environmental damage.
- Nuclear energy is produced by splitting atoms. It also produces radioactive wastes that are very dangerous for many years.

### Lesson Review Questions

#### Recall

1. How does coal form? How are the formation of oil and natural gas different from coal?
2. Waxes can be made from the processing of which fossil fuel?

#### Apply Concepts

3. What environmental problems are caused by surface coal mining?
4. What health problems are caused by underground coal mining?

#### Think Critically

5. Anthracite is the hardest type of coal because it is metamorphic. Anthracite causes less pollution when it burns. Why do you think that is?
6. What properties would a fuel have to have for it to be a good replacement for gasoline? Explain.



## Points to Consider

- How are renewable sources of energy different from non-renewable sources of energy?
- Are all renewable energy sources equally practical?
- Are all renewable energy sources equally good for the environment?

## Vocabulary

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