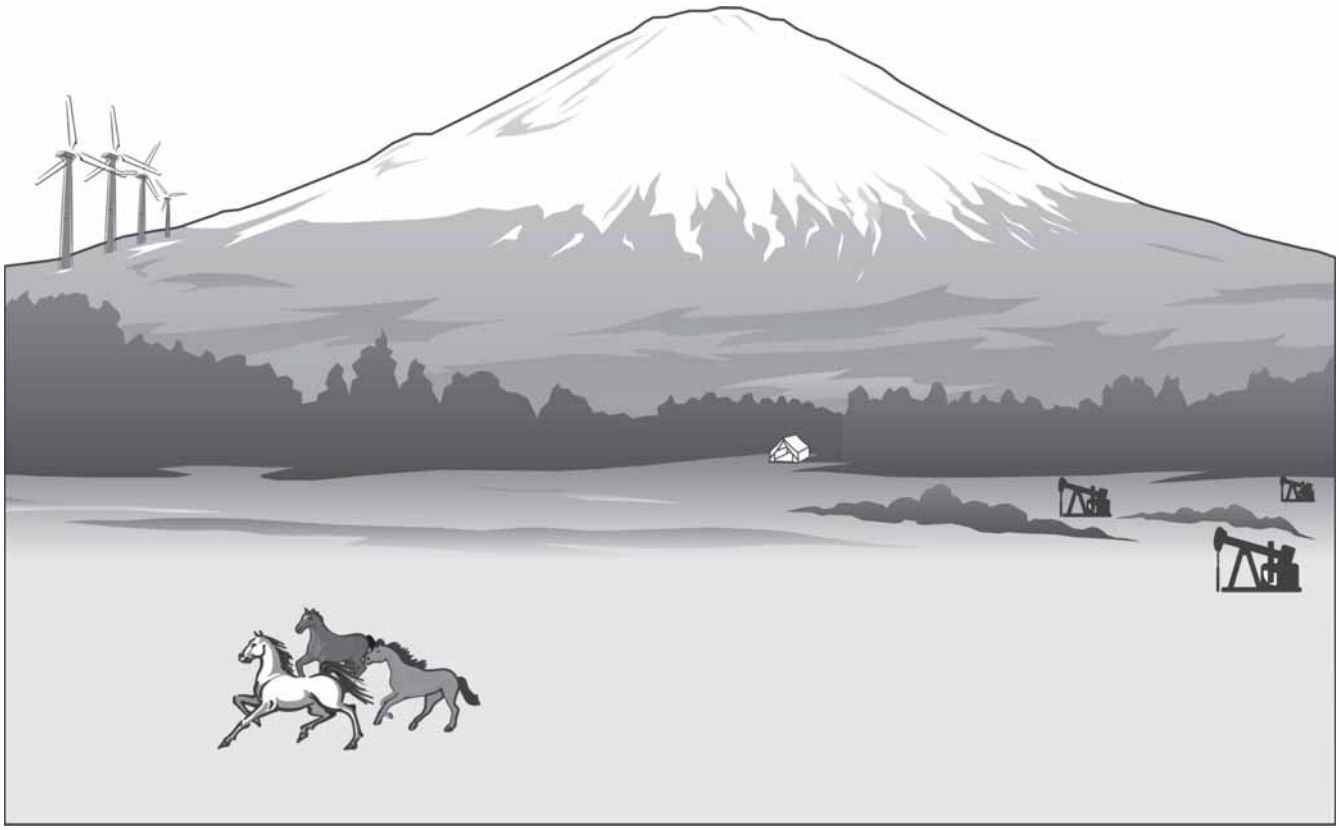
ENERGY ON PUBLIC LANDS

ENERGY SOURCES

GRADE LEVEL
Intermediate

SUBJECT AREAS
Science
Social Studies
Language Arts

Students learn about energy resources found on public lands and how they are managed by the Bureau of Land Management, with background information and cooperative learning activities.



NEED 2008-2009

Putting Energy into Education

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NEED Mission Statement

The mission of the NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Vision Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

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Energy on Public Lands *was developed by The NEED Project with funding and technical assistance from the Bureau of Land Management, U. S. Department of the Interior.*

NEED Master Teacher Constance Beatty of Illinois served as the curriculum development consultant.

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Putting Energy into Education

Correlations to National Science Standards

(Bolded standards are emphasized in the unit.)

UNIFYING CONCEPT 1. SYSTEMS, ORDER, AND ORGANIZATION

a. The goal of this standard is to think and analyze in terms of systems, which will help students keep track of mass, energy, objects, organisms, and events referred to in the content standards.

b. Science assumes that the behavior of the universe is not capricious, that nature is the same everywhere, and that it is understandable and predictable. Students can develop an understanding of order–or regularities—in systems, and by extension, the universe; then they can develop understanding of basic laws, theories, and models that explain the world.

c. Prediction is the use of knowledge to identify and explain observations, or changes, in advance. The use of mathematics, especially probability, allows for greater or lesser certainty of prediction.

d. Order—the behavior of units of matter, objects, organisms, or events in the universe—can be described statistically.

e. Probability is the relative certainty (or uncertainty) that individuals can assign to selected events happening (or not happening) in a specified time or space.

f. Types and levels of organization provide useful ways of thinking about the world.

INTERMEDIATE STANDARD–E: SCIENCE AND TECHNOLOGY

2. Understandings about Science and Technology

a. Scientific inquiry and technological design have similarities and differences. Scientists propose explanations about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations.

c. Technological solutions are temporary and have side effects. Technologies cost, carry risks, and have benefits.

f. Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Risk is part of living in a highly technological world. Reducing risk often results in new technology.

g. Technological designs have constraints. Some constraints are unavoidable, such as properties of materials, or effects of weather and friction. Other constraints limit choices in design, such as environmental protection, human safety, and aesthetics.

INTERMEDIATE STANDARD–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

1. Personal Health

b. Natural environments may contain substances that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

3. Natural Hazards

a. Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans.

b. Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.

c. Hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

4. Risks and Benefits

a. Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences.

b. Students should understand the risks associated with natural hazards, chemical hazards, biological hazards, social hazards, and personal hazards.

c. Students can use a systematic approach to thinking critically about risks and benefits.

d. Important personal and social decisions are made based on perceptions of benefits and risks.

5. Science and Technology in Society

a. Science influences society through its knowledge and world view. The effect of science on society is neither entirely beneficial nor entirely detrimental.

b. Societal challenges often inspire questions for scientific research, and societal priorities often influence research priorities.

c. Technology influences society through its products and processes. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.

d. Science and technology have contributed enormously to economic growth and productivity among societies and groups within societies.

e. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.

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Teacher Guide

TO TEACH STUDENTS ABOUT THE MANY ENERGY RESOURCES ON PUBLIC LANDS IN THE UNITED STATES USING BACKGROUND INFORMATION, GRAPHIC ORGANIZERS, AND HANDS-ON ACTIVITIES.

BACKGROUND

Public lands in the United States have many energy resources, both renewable and nonrenewable. Many of these resources are managed by the Bureau of Land Management (BLM) for the citizens. The Bureau of Land Management's mission includes balancing multiple uses of the land—considering social, economic, and environmental factors.

TIME

Three to ten 45-minute class periods, depending on the number of activities you choose to conduct.

PREPARATION

- ➤ Familiarize yourself with the information and activities in the booklet.
- ➤ Make copies of pages 7-26 of the booklet for each student.

PROCEDURE

Step One—Introduction

Introduce the students to the topic of public lands using the map on pages 14-15 of the booklet. Emphasize the concept that these are lands held by the federal government for the benefit of all Americans.

Step Two—History of Public Lands and the Role of BLM

Have the students read the following sections of the backgrounder and complete the **BLM and Public Lands** graphic organizer on page 20: **Introduction to Public Lands, The History of Public Lands,** and **Public Lands Today.** Discuss the history of BLM and the agency's role in managing public lands.

Step Three—Energy Resources on Public Lands

Have the students read the **Energy Resources on Public Lands** sections of the backgrounder on pages 8-17 and complete the **Energy Resources on Public Lands** graphic organizer on page 21. Discuss the various energy resources on public lands and their advantages and disadvantages.

Step Four—Other Public Land Resources and Their Uses

Have the students read the **Other Resources and Their Uses** section of the backgrounder on page 17. Discuss the importance of these non-energy uses. Ask the students to identify areas in their community that might have multiple uses.

Step Five—BLM's Roles in Managing Energy Resources

Have the students read **The BLM's Roles in Managing Energy Resources** and **The BLM: Balancing Multiple Uses** sections of the backgrounder on pages 18-19, and complete the **Balancing Factors** and **BLM's Roles** graphic organizers on pages 22-23. Discuss the role BLM plays in assuring that public lands are managed in accordance with applicable laws.

Step Six—Reinforcement of Knowledge

Have the students complete the **Public Land Math** and **Definitions** on page 24 to reinforce knowledge of the background material. See the bottom of this page for answers.

Step Seven—Synthesis of Knowledge: Land Use Planning Activity (pages 25-26)

1. Place the students in their groups.
2. Explain the assignment—that students will consider how a parcel of open land on the school grounds should be used.
3. Have the students read the assignment on paghes 25-26 and answer any questions they have. Give the groups a timeframe in which to complete the activity.
4. When the assignment is completed, have the groups make two-minute presentations explaining their plans. Discuss the groups' plans and try to form a consensus within the class.
5. Ask the students to evaluate the activity—what did they learn and what additional information would be helpful to develop a more realistic plan.

Step Eight—Evaluation

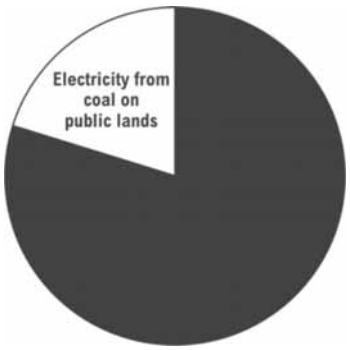
Evaluate the unit using the Evaluation Form on page 27 and send to NEED.

Answers to Reinforcement Activities

Question 1. 21.12 quads

Question 2. 91.25 million barrels per year

Question 3. 18.5 percent



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Energy on Public Lands

Introduction to Public Lands

There are about 2.4 billion acres of land in the United States. Individuals, families, and companies own some of this land. Much of the land, however, is owned or managed by our national (federal) and state governments on behalf of all Americans.

The federal government owns about 681 million acres—or 28 percent—of the land in this country. The land includes familiar areas such as national forests and national parks. Several agencies manage this land, but the Bureau of Land Management (BLM) is in charge of the largest amount. The BLM manages about 261 million acres, mostly in the Western States and Alaska. The BLM lands are often referred to as the **public lands**.

The BLM also manages the natural resources of the public lands, whether they are on the surface or underneath it, such as minerals. The BLM manages mineral resources under other lands as well, including some lands owned by other agencies, private citizens, and Indian tribes. The BLM manages minerals under a total of 700 million acres.

The History of Public Lands

Land owned by the federal government is called the **public domain**. The original public domain of the United States was created between 1780 and 1802 when states gave their claims to western lands over to the federal government. Congress directed that these lands be explored, surveyed, and made available for settlement. It established the General Land Office to oversee these tasks.

By the late 1800s, the public domain stretched from the Appalachian Mountains in the East to the Pacific Ocean in the West.

Most public lands managed by BLM are in the western United States and Alaska.

See pages 14-15 for a detailed map of BLM land.

The government gave much of the land it owned to settlers as they moved west. Under the Homestead Act of 1862, settlers received 160 acres if they farmed and lived on the land for five years. They only had to pay $18 in fees. Thousands of settlers claimed tracts of public land under this act. In addition, from the 1850s to the 1870s, the government granted more than 120 million acres to companies to build railroads. The railroads played an essential role in expanding the settlement of the West.

During this time, Congress began to recognize the natural resource values of the public lands. Congress set some land aside to protect it and designate it for public use. In 1864, Yosemite Valley was granted to the State of California for public use. Yellowstone National Park in western Wyoming became the first national park in 1872.

In the early 1900s, Congress recognized the need to manage activities, such as mining and grazing, on the public lands. In 1934, Congress established the U.S. Grazing Service to manage the public rangelands.

Public Lands Today

In 1946, Congress combined the General Land Office and the Grazing Service to create the BLM. These two agencies had related responsibilities but very different structures. The merger created one new bureau that could manage all activities on public land more effectively.

Today, the BLM's mission is to *"sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations."* A number of important laws, such as the National Environmental Policy Act and the Federal Land Policy and Management Act, have shaped the BLM's role in managing the public lands.

The National Environmental Policy Act became law in 1970. This act made the protection of the environment a national goal. It required all federal agencies to study proposed activities that might alter or disrupt the environment on public lands. They must also issue a report detailing how the area will be affected.

The Federal Land Policy and Management Act of 1976 changed the way public lands are managed. It also gave the BLM some new responsibilities. It officially stated that the BLM should manage public lands for multiple uses. This means that the BLM must balance the competing needs of many people and companies as well as protect the land and resources.

Energy Resources on Public Lands

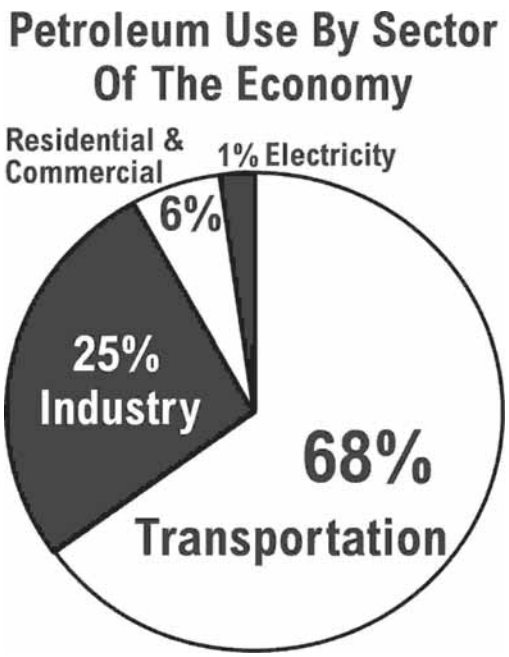
The BLM retains ownership of public land but makes some of it available for certain private or commercial uses. Those uses must be in balance with many other uses of the public lands. One example of commercial use is the removal and sale of energy and mineral resources from the public lands.

The BLM manages these resources but does not actually remove any minerals or produce energy. Instead, the BLM leases the land to companies that want to explore for these resources or remove them from the ground. The companies must agree, as part of their lease agreement, to pay royalties to the BLM. Royalties are a percentage of the price of the resources sold.

The energy resources managed by the BLM fall into two categories. Nonrenewable resources are resources that cannot be replaced as they are used or that can only be replaced very slowly by natural processes. Renewable resources are resources that are continually replenished.

Nonrenewable Resources

Petroleum (oil), natural gas, and coal are examples of nonrenewable resources. They were formed when ancient plants and animals died and became buried under layers of dirt and rock. In some places, ancient seas covered the layers, and then the seas dried up and receded. Over time, the layers created huge pressure. That pressure, when combined with heat from the earth, caused physical and chemical changes that turned the plant and animal remains into deposits of oil, natural gas, and coal. These resources are also called fossil fuels because they come from the remains of once living things.

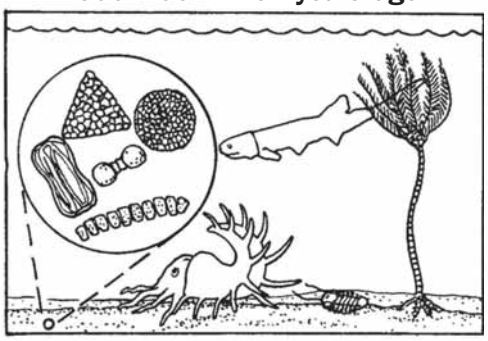


Petroleum

One of the first successful oil wells was drilled by Edwin Drake in 1859 in Pennsylvania. Petroleum became a popular fuel when Henry Ford began producing automobiles. Everyone needed gasoline to run those early cars. Gasoline is still used to run most cars today. About 66 percent of the oil Americans use is for transportation.

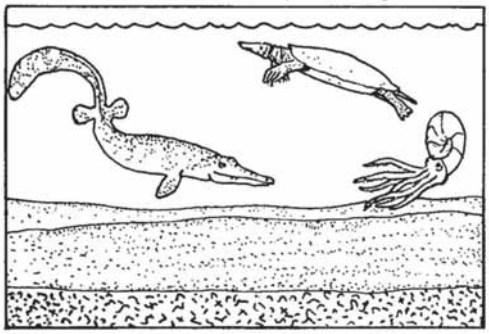
Much of the oil produced in the United States today comes from lands managed by the federal government. The United States produces more than two billion barrels of oil a year. Five percent of this oil, or 100 million barrels, comes from federal lands. In 2005, companies competed to lease almost three million acres of BLM land in 25 states for oil or gas removal. Most of this land was in New Mexico, Wyoming, Colorado, Montana, and Utah.

THE OCEAN
300–400 million years ago



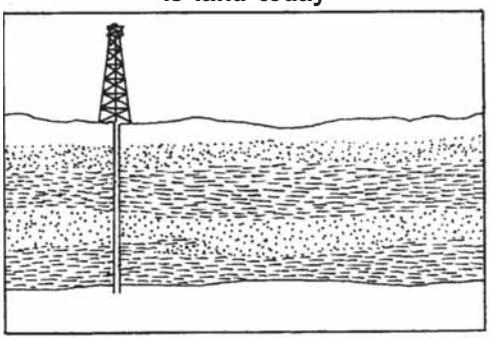
Plant and animal matter, much of it from microscopic organisms called diatoms, died and fell to the ocean floor, where it was buried by sediments washed in by rivers from eroded uplands.

THE OCEAN
50–100 million years ago



Over millions of years, the organic debris was buried deeper and deeper under the sediment. Heat and pressure caused chemical reactions that turned the organic material into oil and gas.

THE ANCIENT OCEAN
is land today



The oil and gas migrated to porous rocks, where heat and pressure have turned the sediments into rocks, and geologic forces have caused the oceans to disappear or shift to other locations.

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No one knows exactly how much oil is underground in the United States, but scientists think there are almost eight billion barrels of oil that could be recovered from federal lands. At this time, not all of the oil can be recovered at a reasonable cost. Removal of some oil may be too expensive for companies.

Once crude oil is found and taken from the ground, it moves through pipelines to a refinery. Pipelines crisscross the United States and many of them cross federal lands. At the refinery, the oil is processed into useful petroleum products, such as gasoline, plastics, and many medicines.

When a well no longer produces oil, it must be capped and closed. Any land that was disturbed must be reclaimed, which means it must be returned, as much as possible, to its natural condition. Before a company can leave an area, the BLM requires it to repair any negative impacts to the environment and prevent conditions from declining in the future.

Petroleum is an important fuel in our society, but its use has drawbacks. Petroleum can pollute the air and water when it is burned. Drilling for oil can cause damage to fragile environments.

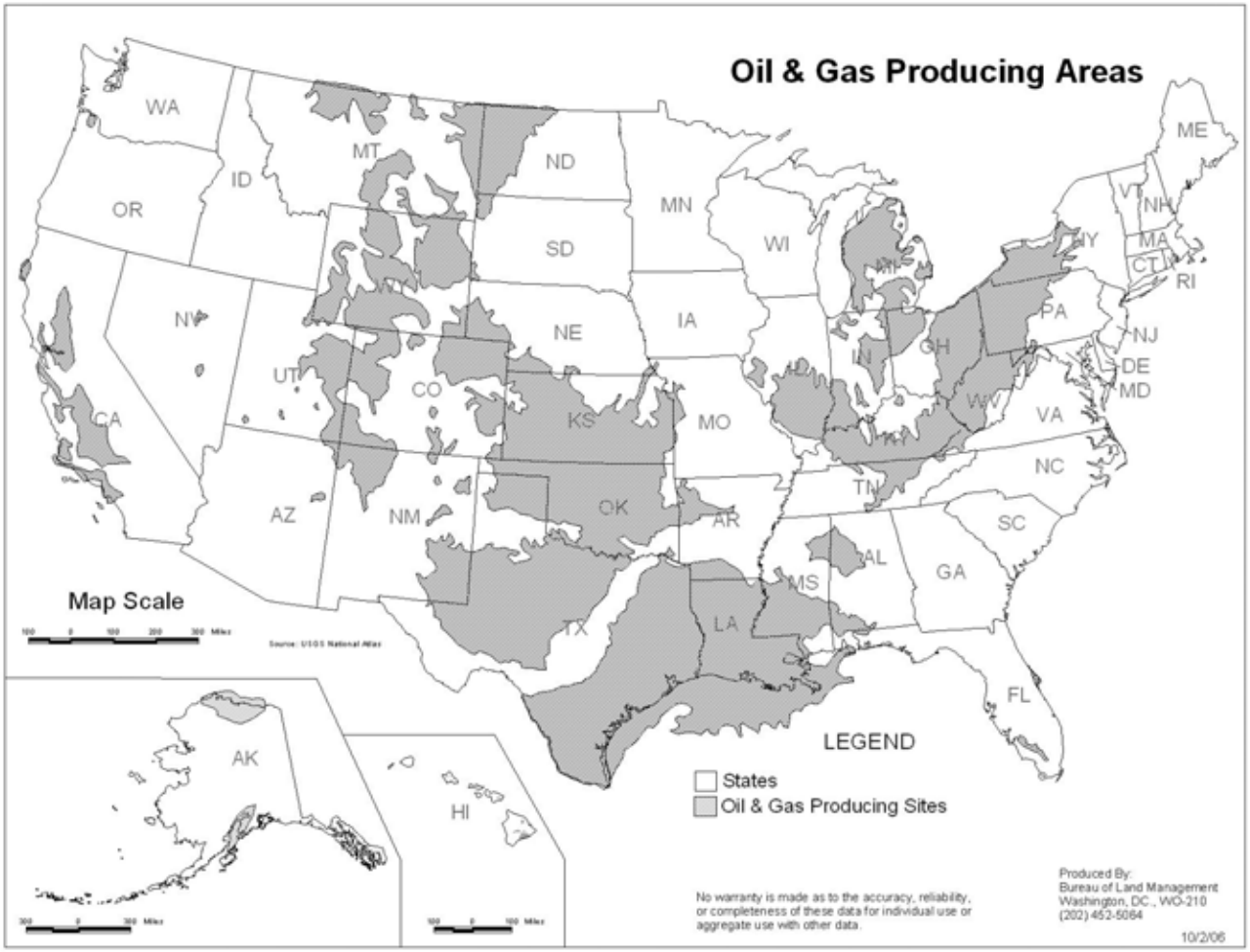
Natural Gas

Natural gas often occurs near oil in rock formations. Natural gas is pumped from the ground, cleaned, and moved through pipelines around the country. Methane, which is the main ingredient in natural gas, is colorless and odorless. A gas called mercaptan, which smells like rotten eggs, is added to natural gas so that a leak can be detected easily.

Natural gas can be found onshore (under land) or offshore (under water and land at the bottom of the ocean). An estimated 201 trillion cubic feet of gas, which could be produced using current technology, lie under federal lands. In fact, 11 percent of the natural gas produced in the United States comes from onshore federal and Indian lands.

Natural gas is used mostly for industrial production and for heating businesses and homes. It is also used to produce electricity and as an ingredient in products such as fertilizers and medicines.

Natural gas, like all fossil fuels, can pollute the environment and produce greenhouse gases when it is burned. It is, however, the cleanest burning fossil fuel and scientists are looking for new ways to use it.



Coal

Coal has a long history in the U.S. North American Indians used coal before the first settlers arrived. The Hopi Indians used coal for cooking, heating, and baking pottery they made from clay. European settlers found coal during the 1600s, but they used very little at first. In the 1800s, coal was used to manufacture goods and power steamships and train engines. During the Civil War, coal was used to make iron and steel. Electricity was generated with coal by the end of the 1800s.

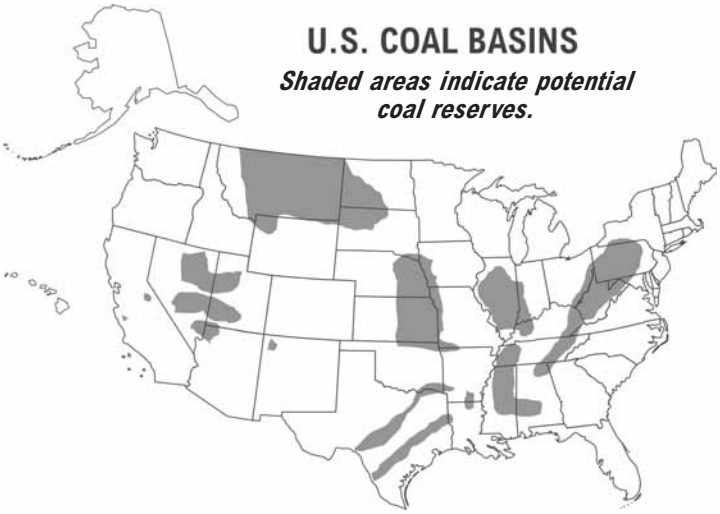
Coal miners use two methods to remove coal from the ground: surface mining and underground mining. Surface mining is used to obtain most of the coal in the U.S. Surface mining can be used when the coal is buried less than 200 feet underground. In surface mining, giant machines remove the topsoil and layers of rock to expose large beds of coal. Once the mining is finished, the dirt and rock are returned to the pit, the topsoil is replaced, and the area is reclaimed.

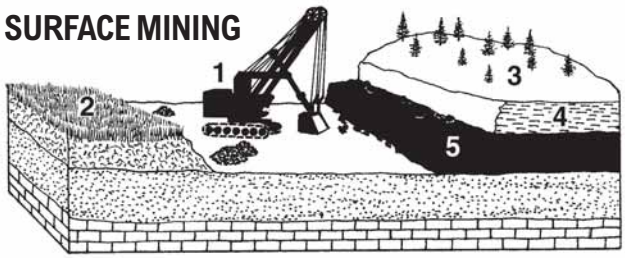
Underground mining is used when the coal is buried deep within the earth. Some underground mines are 1,000 feet deep. To remove coal from these mines, miners are transported down deep mine shafts to run machines that dig out the coal. Most underground coal mines are in the eastern United States.

After the coal is taken out of the ground, it is transported to a preparation plant to be cleaned. Trains transport most of the coal. Sometimes river barges and trucks move coal. The preparation plant removes rock, ash, sulfur, and other impurities from the coal.

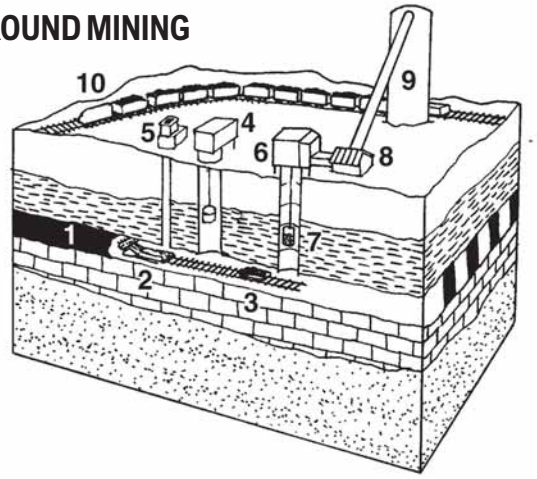
When burned, coal produces carbon dioxide and sulfur and can pollute the environment. Carbon dioxide is one of the greenhouse gases. This means that, like a greenhouse, it traps energy from the sun, causing a rise in the earth's temperature. Sulfur can mix with oxygen to form sulfur dioxide and with water to form acid rain. Acid rain contributes to the damage of many trees and forest soils. It also accelerates the decay of paint and building materials, which can cause damage to many historic buildings, statues, and monuments. Coal companies look for coal with a low sulfur content to mine. Power plants that burn coal are installing scrubbers, which are devices that remove most of the sulfur from coal smoke.

Coal reserves are beds of coal that have not yet been mined. The United States has the world's largest known coal reserves, many of which are under federal lands. Americans use about 1,100 million short tons of coal a year. One short ton equals 2,000 pounds. Nearly 440 million short tons, or 40 percent, come from under federal lands. Coal provides over 50 percent of the electricity and almost 25 percent of the total energy consumed in the United States. In fact, over 90 percent of the coal that is mined is used to generate electricity.





1. Coal shovel
2. Reclaimed land
3. Topsoil
4. Overburden
5. Coal seam



1. Coal seam
2. Continuous miner machine
3. Coal car
4. Hoist house
5. Fan
6. Skip house
7. Skip
8. Breaker house
9. Silo
10. Train

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The BLM does not mine coal. Private companies conduct the mining operations. A company must get a lease from the BLM to mine coal on any parcel of federal land. Currently, there are about 125 producing coal leases on federal land. A producing lease is a lease for land from which coal is being extracted. If a company has a lease but is not extracting coal, the lease is not considered a producing lease.

Renewable Energy Resources

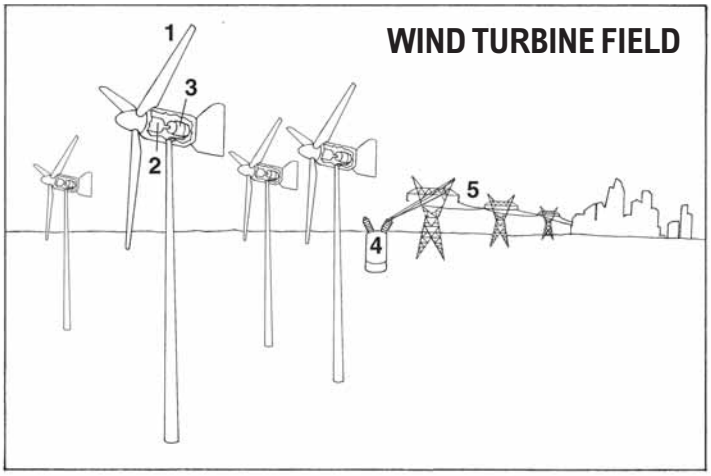
Renewable energy sources are resources that will last forever or that can be replenished in a short period of time, such as wind, hydropower, geothermal energy, biomass, and solar energy.

Wind

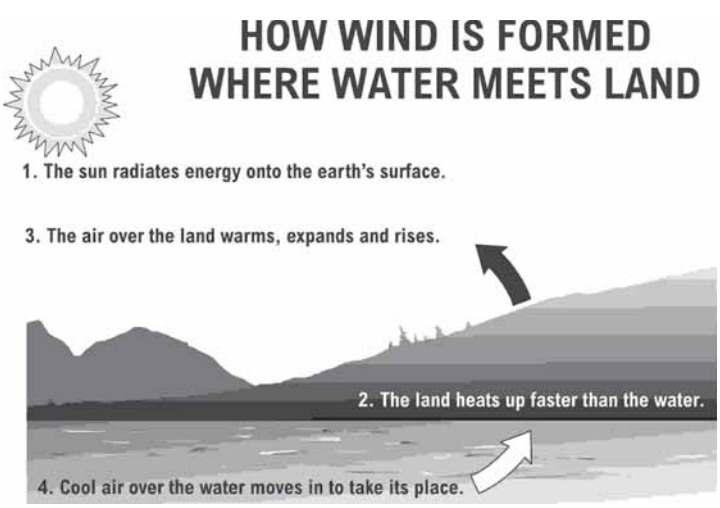
Wind is air in motion. The uneven heating of the earth's surface by the sun produces wind. Different land and water formations cover the earth's surface, causing it to absorb the sun's radiation unevenly. During the day, the air above the land heats up faster than the air above water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds.

Large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than land near the North and South Poles.

People have used wind for energy for thousands of years. Ancient Egyptians used wind to sail ships more than 5,000 years ago. In the United States, colonists used windmills to grind wheat and corn, pump water, and cut wood in sawmills.



1. The wind spins the blades of the turbine.
2. The blades are connected to a spinning shaft.
3. The shaft turns a generator that produces electricity.
4. Electricity flows to a transformer that boosts the voltage.
5. Electricity is transported over transmission lines into a city.



Today, people use wind energy to generate electricity. The wind turns the blades, which are connected to a drive shaft. The drive shaft turns an electric generator to make electricity. Wind power plants, or wind farms, have clusters of wind machines that are used to produce electricity. They are usually owned by private companies that sell the electricity to public utilities.

Wind farms are built where conditions, such as wind speed and direction, are most favorable. As a rule, wind speed increases with height and over open areas with no windbreaks. The BLM works with companies to find the most suitable sites on public land for wind farms and to minimize disturbances to the land, wildlife, and public.

Wind is a clean source of energy, causing no air or water pollution. However, one problem with wind energy is that it is affected by the weather. When there is either not enough or too much wind, the wind machines do not produce energy efficiently. Another problem is that bird and bat populations are being injured by wind machines in some areas.

The future development of wind energy depends upon finding open lands for wind farms. The BLM manages many of the lands with the best wind potential. In fact, 46 percent of the BLM land in Nevada could be commercially developed for wind energy. Right now, about five percent of the wind machines installed in the United States are on public lands.

California has installed many wind machines on public lands. The California Wind Energy Project near Palm Springs generates 315 megawatt-hours of electrical power. That is enough power to meet the average needs of about 80,000 households. The electricity from this project is generated by 2,960 wind machines installed on public land.

Solar

Solar energy is available every day. The sun radiates (sends out) more energy in one second than the world has used since time began. Only a very small part of this energy hits Earth. However, if it could be harnessed, the sunlight that reaches Earth in one day could supply our nation's energy needs for one year.

Even though solar energy is all around us, harnessing it can be difficult. The energy from the sun is spread out over a large area. A concentrated amount does not hit any one place at a given time. The time of day, season of the year, cloudiness of the sky, and distance from Earth's equator all affect the amount of solar energy an area receives.

Solar energy can be used in many ways, such as to heat the inside of buildings. Some buildings have passive solar systems. They are designed to let in and collect as much sunlight as possible. The light comes through the windows; is absorbed by the furniture, walls, and floors; and changes into heat. Other buildings have active solar systems. They use special equipment to collect sunlight and heat the buildings.

Solar energy can also be used to heat water. Today, more than 1.5 million homes and other buildings in the United States use solar water heaters. The Department of the Interior operates more than 40 solar hot-water systems on its properties.

Solar energy can generate electricity as well. Electricity can be generated in two ways: using a photovoltaic system or using a solar thermal system. Photovoltaic cells, sometimes called PV cells or solar cells, are made of silicon, the same substance in sand. When sunlight hits a solar cell, it causes electrons to move, producing electricity. Solar thermal systems use solar energy to superheat a liquid. The liquid releases steam that spins a turbine, which, in turn, propels a generator to produce electricity.

Currently, solar energy provides less than 0.1 percent of America's electricity. Compared to other ways of making electricity, solar electricity is expensive. Yet, as the technology improves, it is becoming more cost-effective and popular. In areas that are far from electric power lines, solar energy is often the best way to generate electricity.

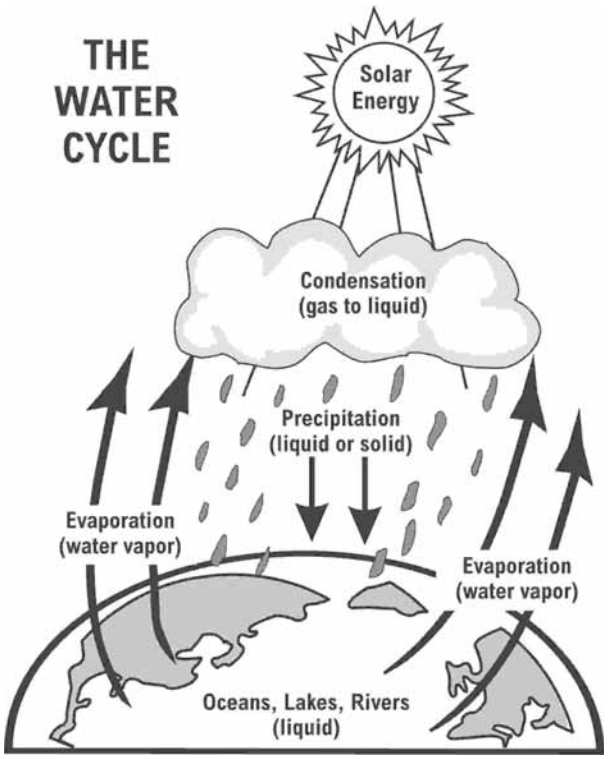
Federal lands, especially in the western United States, have very high potential for both photovoltaic and solar thermal energy production. The Department of the Interior has around 400 facilities that use solar PV systems.

SOLAR HEATING

1. **Sunlight enters the solar collector on the roof and heats antifreeze in the collector's tubes.**
2. **The heated antifreeze is piped into the walls of a storage tank.**
3. **Waters enters the house and flows to the storage tank.**
4. **The water absorbs heat from the antifreeze in the walls.**
5. **The warmed water flows into the home's water heater.**
6. **The water is used as needed.**
7. **The cool antifreeze returns to the solar collector.**

Hydropower

Hydropower is the energy in moving water. Water flows through the earth's natural system in a continuous cycle. The sun evaporates moisture from the oceans and rivers and the moisture condenses into clouds. When the moisture is released from the clouds, it falls back to the earth in the form of rain or snow.



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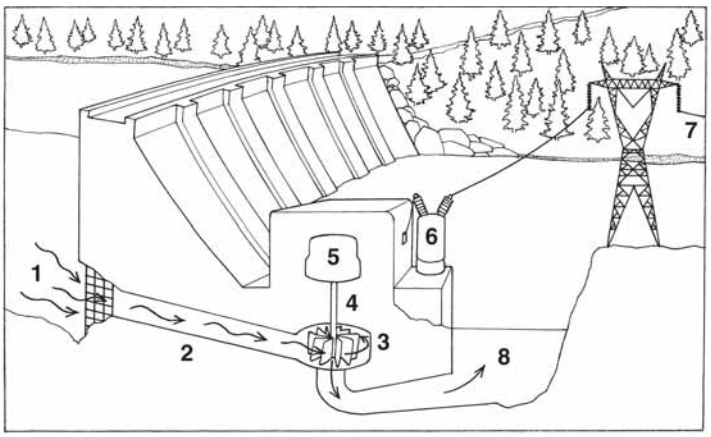
Water has been producing energy for humans for thousands of years. More than 2,000 years ago, the Greeks used water wheels to grind wheat into flour. Then, in the early 1800s, American and European factories used water wheels to power machines. In the late 19th century, people began to use water to produce electricity. The first hydropower project was located on the Fox River in Appleton, Wisconsin, in 1882. Other hydropower plants followed, such as the one built at Niagara Falls. It is easiest to build hydropower plants where there are natural waterfalls.

Another way to use water to produce electricity is to build a dam. A dam can be built on a river, stopping the flow of water and creating a lake or reservoir behind it. When water is allowed through the dam, the force of the falling water spins the blades of a turbine to produce electricity. With dams, water can be stored and released when it is needed the most. When people need less electricity, like at night, the gates can be closed so that the water is held in the reservoir. Then, when electricity is needed during the day, the gates can be opened.

Like all energy sources, hydropower has advantages and disadvantages. It can be a cheap way to generate electricity if the flowing water is free to use. It is also a clean way to generate electricity. Hydropower plants do not burn fuel or emit any pollutants.

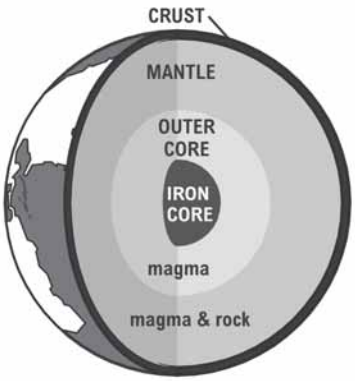
HYDROELECTRIC POWER PLANT



1. **Water enters the system through intake grates at the bottom of the reservoir behind the dam.**
2. **Water travels down the penstock (tunnel).**
3. **Moving water spins the blades of a turbine.**
4. **Rotating blades turn a shaft.**
5. **Turning shaft activates a generator that produces electricity.**
6. **Electricity flows to a transformer that boosts its voltage.**
7. **Electricity is transmitted along power lines to customers.**
8. **Water returns to the system downstream of the dam.**

Dams for hydropower plants can also control floodwaters and provide lakes for recreation. However, dams do alter the environment. Damming rivers may disturb wildlife, natural resources, or towns. When a reservoir is created, it floods acres of land, and puts plants, trees, and wildlife habitat under water. Dams can also cause upstream flooding and deplete downstream flows.

Currently, hydropower generates about seven percent of America's electricity. About 28 million American homes use electricity from hydropower. Hydropower accounts for most of the electricity produced from renewable resources. There are approximately 550 hydropower projects associated with BLM lands.



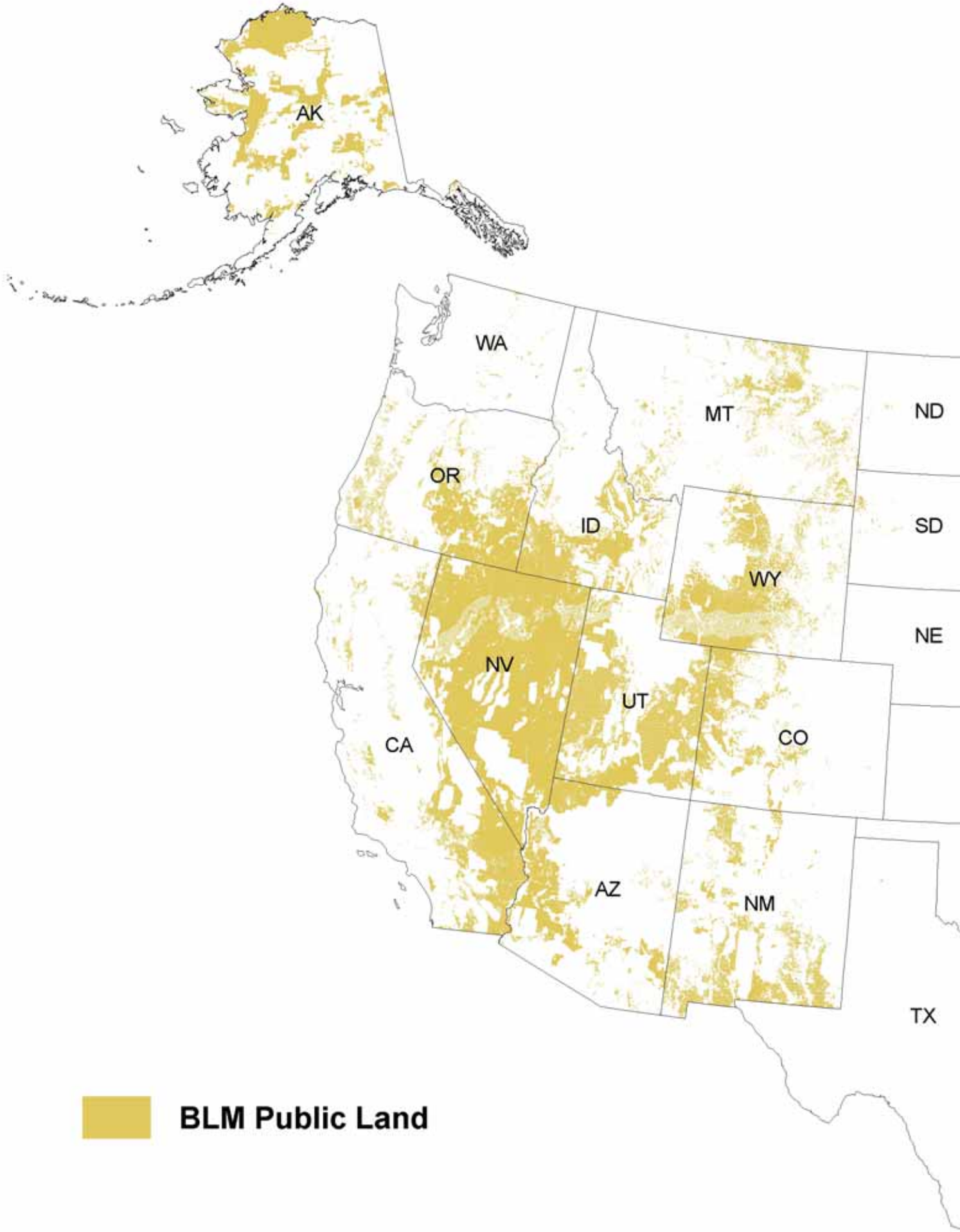
THE EARTH'S INTERIOR

GEOTHERMAL

Geothermal energy is generated in the earth's core. Very high temperatures are constantly produced inside the earth by the slow decay of radioactive particles. This process is natural in all rocks.

The core of the earth is made up of magma, and the mantle is made up of magma and rock. The outermost layer of the earth is called the crust. The crust forms the continents and the ocean floor. This layer is not a solid piece. It is broken into plates. Hot magma comes close to the earth's surface near the edges of these plates. Deep underground, rocks and water absorb heat from the magma. This heat can be collected by digging wells and pumping the heated water to the surface. The water travels through pipes to a plant, where the steam separates from the water and is either used directly or to turn a turbine to produce electricity.

Geothermal energy is used for heat and electricity all over the world. People have been using geothermal energy for heating since ancient times. Using geothermal energy to make electricity began in the early 1900s, but it wasn't until 1960 that the first successful American geothermal plant—called The Geysers—began operating. The plant is located on public land near Ukiah, California.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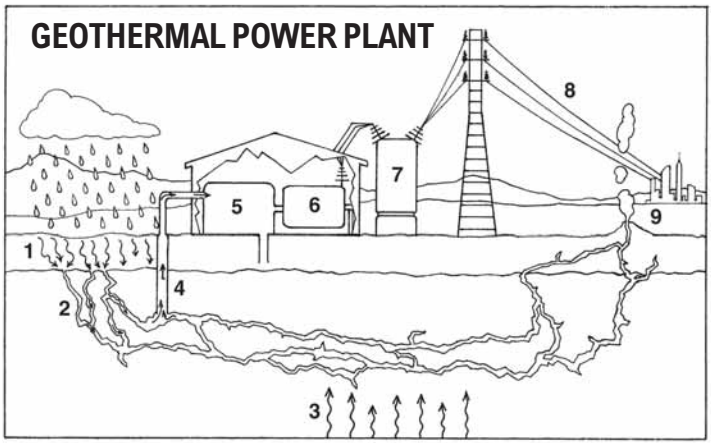
BLM Public Land

Bureau of Land Management
Public Lands

Most geothermal resources are in the western United States because of the geography of the continent. Many of the best sites for potential geothermal development are on BLM-managed land. Nearly half of the energy from geothermal resources in the U.S. is produced on public lands. Geothermal power generated on BLM-managed lands provides electricity to about 1.2 million homes. This energy comes from 60 sites, mostly in California, Nevada, New Mexico, Utah, and Oregon.

Geothermal energy is a clean source of energy. Since geothermal power plants do not burn fuel, they release almost no emissions. Additionally, transportation of the fuel is not required since geothermal power plants are built above their fuel source. However, there are limits to where geothermal power plants can be built. The underground heat must be close enough to the surface to be easily accessed.



1. Rainwater percolates into the ground.
2. The water enters a fissure system in the bedrock.
3. Heat from magma radiates upward and turns the water into steam.
4. Geothermal steam is captured by a pipe that has been inserted into the bedrock.
5. Steam spins the blades of a turbine, rotating its shaft.
6. Spinning shaft powers a generator to produce electricity.
7. Electricity flows to a transformer that boosts the voltage.
8. Electricity is transmitted along power lines to the city.
9. Steam leaves the ground from a geyser.

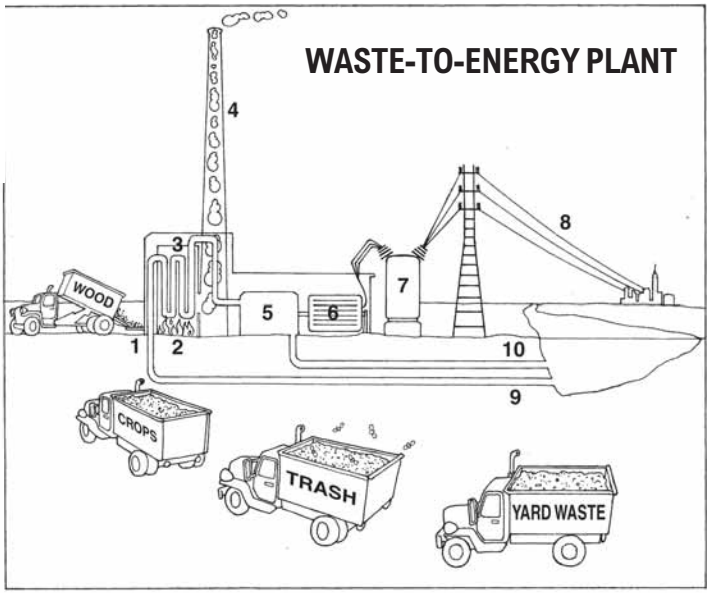
Biomass

Biomass was one of the first energy sources used by humans. It is still used today. Biomass is organic matter, or anything that was once alive. Wood, crops, and yard and animal waste are examples of biomass. Biomass energy can be harnessed in different ways. One way is to burn biomass. Most of the energy in the U.S. until the mid-1800s came from burning wood. Today, wood provides only a little of our country's energy needs. Garbage can also be burned to produce electricity. Power plants that burn garbage are called waste–to–energy plants.

The major advantage of burning waste is that it reduces the amount of garbage we bury in landfills. Waste-to-energy plants dispose of the waste of 40 million people. Some people are concerned that burning garbage may harm the environment. Like coal plants, waste-to-energy plants produce air pollution when the fuel is burned. Burning garbage releases the chemicals and substances found in the waste. Some chemicals can be dangerous to people, the environment, or both, if they are not properly controlled. However, burning biomass causes less pollution than burning fossil fuels.

A second way biomass can be used is through bacterial decay. Bacteria feed on dead plants and animals and produce a gas called methane. Methane is a good source of energy. It can be burned to produce heat or electricity. Landfills produce methane. Some have systems that can capture it and use it as an energy source.

Biomass can also be converted into a gas or liquid fuel by adding chemicals or heat. Adding yeast produces an alcohol known as ethanol. This fuel can be burned to produce heat or electricity, or it can be used as automobile fuel.



1. Biomass is introduced into the system by a conveyor belt.
2. The biomass is burned in the furnace.
3. Water flows through a pipe in the furnace, turning into steam.
4. Smoke from the furnace goes up the chimney.
5. The steam turns the blades of a turbine, rotating its shaft.
6. The shaft powers a generator to produce electricity.
7. A transformer boosts the voltage of the electricity.
8. Electricity is transmitted along power lines to the city.
9. Water enters the system through a pipe from a reservoir, lake, river or stream.
10. Condensed steam returns to the water source.

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Usually, ethanol is mixed with gasoline to produce a fuel called E10 (90 percent gasoline and 10 percent ethanol). One drawback of burning ethanol is that it releases carbon dioxide. However, plants grown specifically to produce ethanol may reduce this greenhouse gas since plants use carbon dioxide and produce oxygen as they grow.

Biomass resources currently generate about 1.5 percent of America's electricity. However, there is potential for more biomass generation around the country. The BLM is currently working on projects designed to prevent forest fires and create biomass resources for electricity production. Removing excess biomass from forests clears the land of the organic material that burns and helps spread forest fires. This organic material—trees, branches, shrubs, and other plants––can be taken to a facility to be burned to produce electricity. The BLM estimates that these projects could create as many as 650 gigawatt-hours of electricity each year.

The BLM also provides biomass from areas where plant material is removed from public lands. The Modoc Plateau in California has been invaded by juniper plants, which take over areas and force out native plants. The BLM is working to remove juniper plants from some public areas. The plants are cut down, sent to nearby bioenergy and cogeneration facilities, which burn both coal and biomass, and used as a source of energy.

Other Resources and their Uses

BLM lands also contain a wealth of other resources. Exploration and removal of energy resources must be balanced with numerous other activities, as well as with the protection of the public lands and resources.

Grazing

Thousands of acres of public land are open range. For many years, ranchers have leased public lands to graze their livestock. The BLM is responsible for leasing and monitoring grazing on these lands. Ranchers are limited in the kind and number of animals they can graze, depending on the size of the leased area, to ensure that the land suffers no permanent damage.

Forestry

There are 55 million acres of forests and woodlands on BLM land. Much of this land contains valuable timber resources. In many areas, timbering companies have leases that allow them to harvest some of the trees. The BLM works to protect forest and woodland ecosystems by limiting the type, size, and number of trees that the companies cut.

Wildlife Habitat

A great variety of wildlife species live on public land. The BLM's wildlife program consists of three components: protection of wildlife habitats, fish habitats, and threatened and endangered species. Leases or permits issued by the BLM for activities on public lands include requirements that protect fish and wildlife habitats. The BLM must carefully evaluate activities that could harm the habitat of threatened or endangered species such as bighorn sheep and desert tortoises. The BLM is also responsible for protecting wild horses and burros on public land.

Recreation

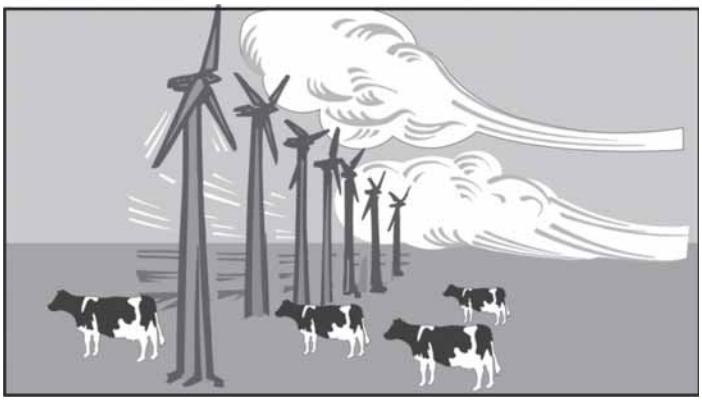
Millions of people visit public lands each year for recreation. They swim, fish, hike, camp, and enjoy many other recreational activities and the beauty of wilderness areas. The BLM must balance recreation with other uses and ensure that Americans enjoy their public lands safely and responsibly, without causing damage to the landscape.

Historic Preservation

Public lands include hundreds of thousands of archeological and historical sites. These sites document thousands of years of human history. They include, for example, prehistoric cliff dwellings, mysterious rock art, and Anasazi pueblos. Public lands also include many paleontological sites, where dinosaur bones and other fossils that tell us about the development of life on Earth have been found. The BLM is responsible for protecting, studying, and managing all of these cultural and fossil resources.

BLM's Roles in Managing Energy Resources

The BLM has many roles in managing public lands and resources. One of the BLM's main responsibilities is to determine what types of activities can occur on specific pieces of public land. This is done through the land use planning process.



Developing a Land Use Plan

Whenever any kind of activity is proposed for public lands, the BLM must evaluate several factors:

Social Impacts—The effects on local people, as well as their opinions about the project, are examined to determine if a proposed use would benefit or hurt the local community. The BLM must also consider if a use could affect people outside of the local area. Community involvement in BLM projects is an important way to address these social concerns.

Economic Impacts—The BLM must evaluate whether the proposed activity will help the local and national economies by providing jobs and encouraging spending and development in nearby areas.

Environmental Impacts—The BLM examines all possible environmental impacts to the land itself, the plants and animals that inhabit the area, and the communities near the area. Many of the areas the BLM manages are like no other places in the world, and those environments must be protected and preserved.

Once these and other factors, such as legal constraints, have been studied for a parcel of land and the public has had opportunities to provide input, the BLM prepares a land use plan. A land use plan is a detailed guide explaining what activities will be allowed on the land. It also describes how the activities will be managed and monitored to make sure the plan is being followed. The plan must meet all governing laws and regulations before it is approved.

Offering Lands for Lease

If energy and mineral development are allowed in the land use plan, the BLM offers lands for lease. Companies bid for the right to develop energy and mineral resources on public lands. If there is a piece of land with known reserves of minerals, companies bid for the rights to the minerals. The BLM holds an auction during which companies compete, or place competitive bids, to win the right to use the land. If the land is offered competitively at auction and no bids are received, the BLM can accept a noncompetitive bid. With this type of bid, a company applies for the right to use the land without competing with other companies.

Issuing Permits, Licenses, and Rights of Way

Another of the BLM's roles is to authorize every use of the land. The BLM does not remove any energy resources. Instead, the BLM grants permits to private companies to explore and develop the resources. Once a company has been awarded a lease, it must obtain permits from the BLM and all other agencies that regulate the planned use, such as the Environmental Protection Agency. Permits ensure that laws regarding safety and protection of the environment are followed. Permits must be renewed every few years to ensure that companies are taking proper care of the land.

The BLM gives permission to an individual or company to use a piece of public land for a specific facility and period of time by granting a right-of-way. Rights-of-way are important for getting energy to where it is needed. They are granted for power lines, pipelines, railways, and other devices that travel across long distances. Rights-of-way can also be granted by private landowners.

Many rights-of-way are granted to energy transporters. Today, more than 17,000 miles of oil and gas pipelines cross BLM land. Most of the oil and gas pipelines in the West cross public lands at some point. Electricity generators also need rights-of-way for their transmission lines. Power lines must sometimes travel long distances from where the electricity is generated to where it is used. More than 50,000 miles of rights-of-way have been granted for power lines to cross public lands to ensure that electricity reaches consumers.

Rights-of-way must also be granted for wind farms built on public lands. Wind turbine blades are large, so they require a large amount of room in the air, but the base of a wind machine takes up very little room on the ground. Rights-of-way may be granted to install wind machines on public land that is also used for other activities, such as animal grazing. This is one example of how the BLM manages public lands for multiple uses.

Inspecting Activities & Enforcing Regulations

Once a company has a lease to develop the resources on a piece of land, the BLM sends inspectors to the operation to make sure that the laws are being followed. The BLM must ensure that the health and safety of the company's employees and the public are protected and that environmental impacts are minimized.

Inspectors may make appointments for visits, but they also have the right to make surprise visits to the leased land. Inspectors report their findings to the BLM.

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Companies are also required to report their activities to the BLM. If an inspector reports that laws are not being obeyed, the BLM must enforce those laws. Most of the time, companies work within the laws. Companies that don't obey the laws can be punished or fined for illegal activity.

Coordinating Closure and Reclamation

In the past, companies were not required to restore the land after they recovered mineral resources and closed their operations. This led to environmental problems that are still being addressed today. Now the BLM requires companies to safely seal off the sites when they are finished working on the land. They must remove all equipment and close all wells and mine entrances. They must ensure that the health and safety of people are not at risk and that the environment has as little permanent damage as possible.

The BLM also requires companies to reclaim, or restore, the land they have disturbed. Returning soil, planting plants, and reintroducing animals are all examples of restoration activities. Exactly how a company reclaims the land is determined by the company and the BLM.

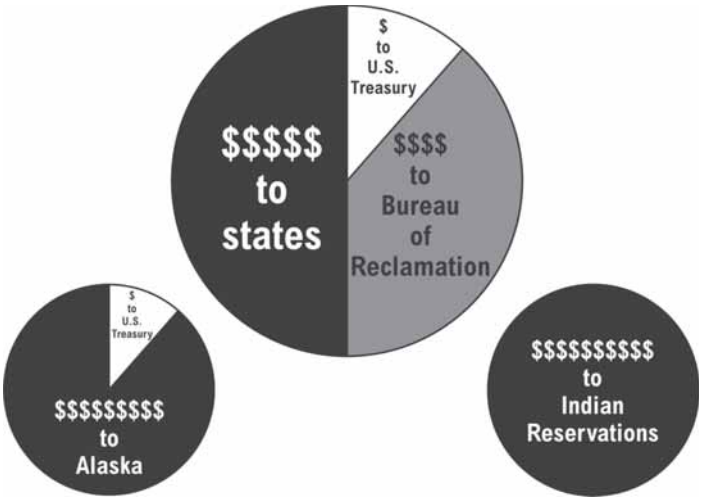
Collecting and Distributing Money

The BLM is responsible for collecting fees from companies that lease land and remove minerals. In 2004, the BLM collected over $2.3 billion from users of public land. Most of this came from mineral royalties, rents, and bonuses.

Companies must pay royalties when they extract minerals from BLM land. Royalties are paid based on the amount of minerals extracted. The more minerals taken out, the more the companies must pay. Companies must also pay rent for the use of BLM land. Rent is a set amount agreed upon when a lease is given. The company must pay rent even if no minerals are taken out of the land. When lands are competitively leased, companies pay bonuses for getting the land. These bonuses are one-time payments and can vary in amount.

Money that is collected from companies that lease Federal lands is split in several ways. Generally, 50 percent of the money goes back to the state in which the land was leased. It is up to the state government to decide what to do with that money. In many cases, much of the money goes to communities near the leased land. Local governments use the money for schools, roads, and other community improvements.

Under certain circumstances, the money is split differently. In Alaska, 90 percent of the money collected is returned to the state. Also, any money collected from



companies with leases on Indian lands goes directly to the Indian tribes that occupy those lands or to individual Indian mineral lease owners.

Some of the money collected from leasing goes to the U.S. Treasury. It is then distributed into several accounts. One account, the Reclamation Fund, is used for water projects in the West. Another account, the Land and Water Conservation Fund, is used to help state and local governments develop outdoor recreation opportunities and purchase federal land for parks and recreation.

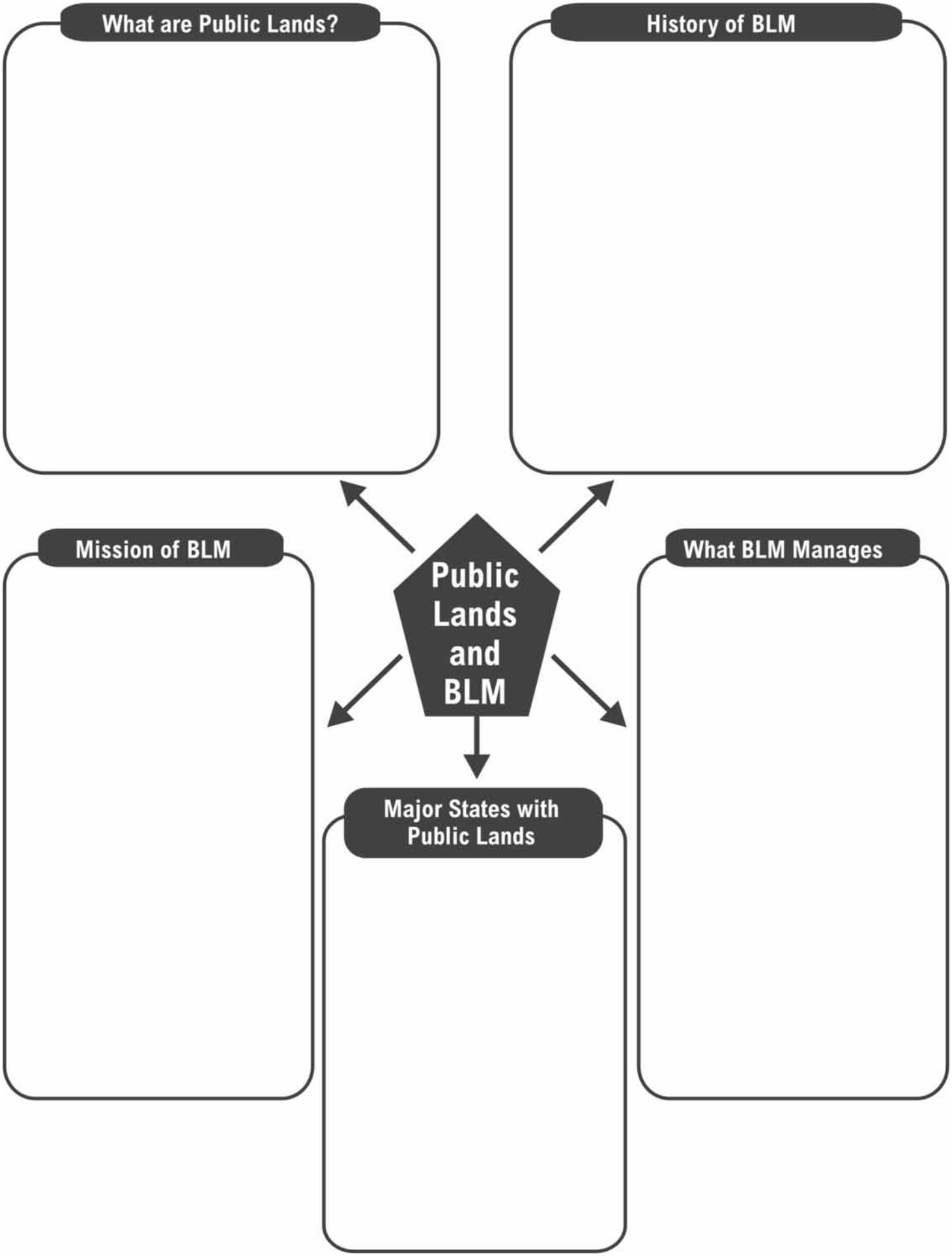
The BLM: Balancing Multiple Uses

The public lands contain a wide variety of resources. While these lands offer great potential for supporting the energy needs of our nation, they also offer opportunities for many other uses, as well as unique scenic beauty.

The BLM must balance many competing uses on public lands, responding to the demand for growth as well as the demand for conservation. When determining uses for public lands, the BLM must consider:

- Air and water quality;
- Recreation, wildlife, cultural, and fossil resources;
- Contributions to a sound economy through energy, food, and fiber production; and
- Support for local communities and their heritage.

It must also balance the desires of local communities with the needs of the nation as a whole, because the public lands belong to all Americans. The BLM must ensure that all of the lands and resources entrusted to it are used in a variety of ways for the benefit of all Americans.

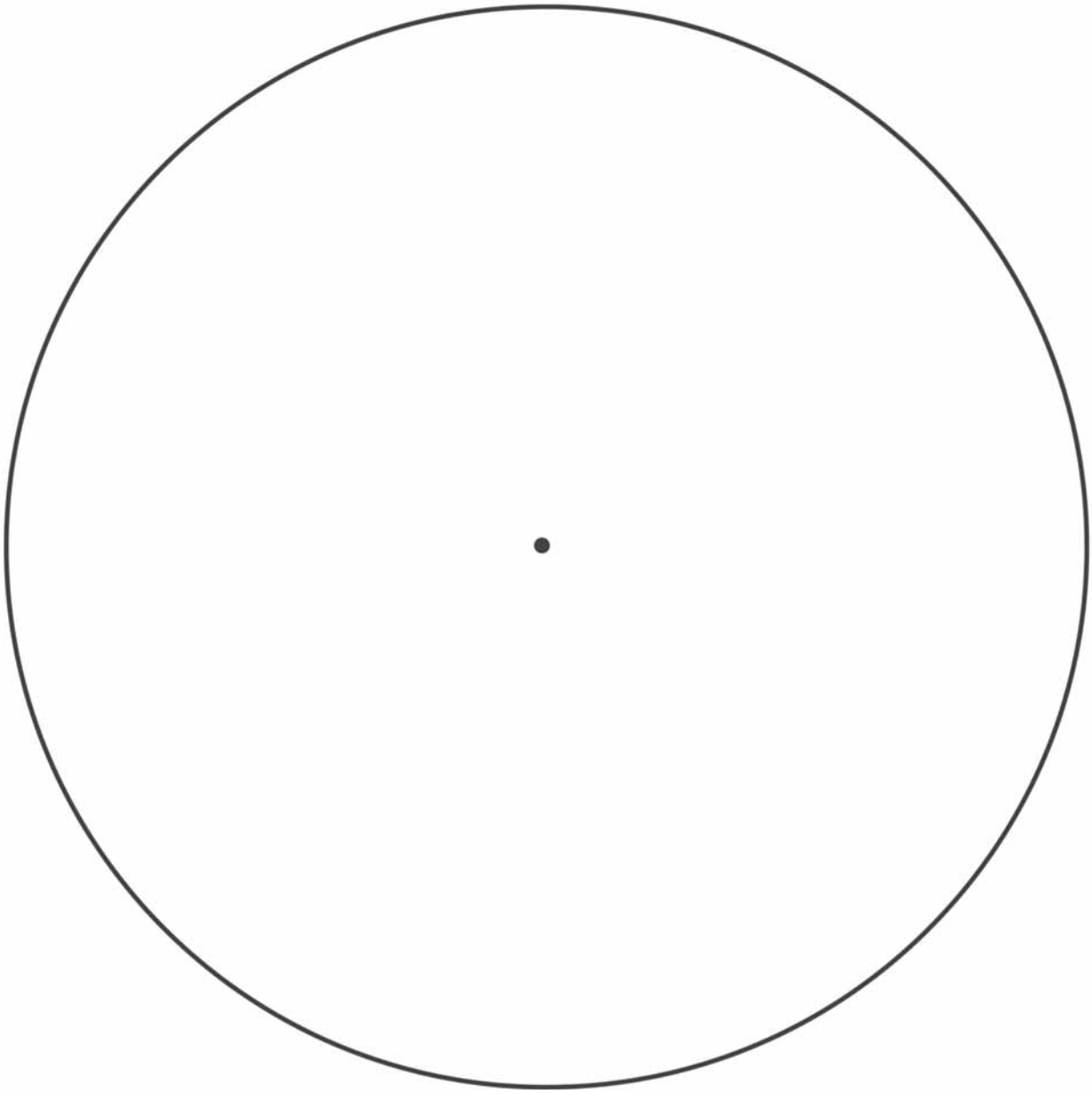

What are Public Lands?
History of BLM
Mission of BLM
Public Lands and BLM
What BLM Manages
Major States with Public Lands

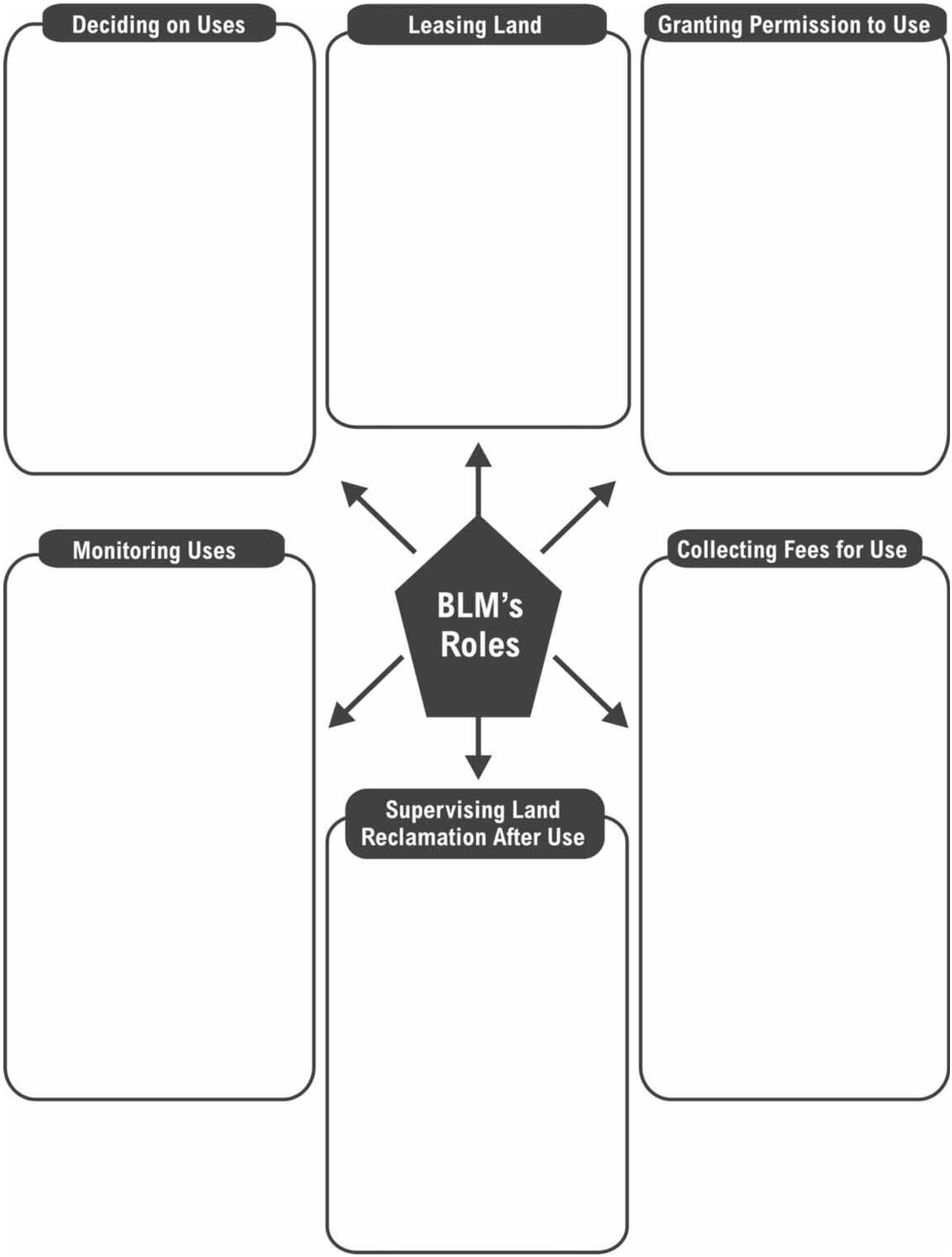
ENERGY RESOURCES ON PUBLIC LANDS

Energy Resource	Formation	Important Facts - Advantages and Disadvantages

BALANCING FACTORS

Make a pie graph that shows the three factors BLM considers in its public land use decisions and how important you think each of the factors should be. Below the graph, write a paragraph explaining why you think the factors should be balanced this way.




Deciding on Uses
Leasing Land
Granting Permission to Use
Monitoring Uses
BLM's Roles
Collecting Fees for Use
Supervising Land Reclamation After Use

Public Land Math

Answer the following math questions.

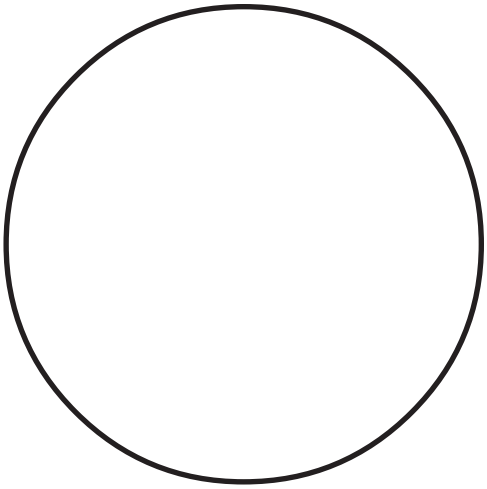
1. **The U.S. produced 70.4 quads of energy in 2004. If 30 percent of that energy came from public lands, how many quads of energy were produced on public lands in 2004?**

2. **If five percent of the oil produced in the U.S. comes from public lands and the U.S produces approximately 5.0 million barrels of oil a day, how many barrels of oil come from public lands each year?**

3. **On the circle, make a pie chart showing how much of our electricity comes from coal on public lands, using the following information:**

   50 percent of the electricity in the U.S. comes from coal.

   37 percent of U.S. coal comes from public lands.



Definitions

Define the following words found in the background information.

Public Lands

Mineral Rights

Fluid Minerals

Solid Minerals

Royalty

Bonus

Rent

Right of Way

Fossil Fuel

Surface Mining

Underground Mining

Reserve

Lease

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Land Use Planning Activity

Introduction: As you have learned, the BLM manages the public lands for multiple uses. But how does the agency determine which uses will be allowed in a particular area? Land use plans form the basis for every action the BLM takes and every use that is allowed. The planning process involves thorough consideration of the land, its resources, and all possible uses that may occur during the life of the plan. Most BLM land use plans cover a period of between 10 and 20 years.

When the BLM wants to pursue a particular use, it develops a specific activity plan. The BLM must first ensure that the proposed activity is consistent with the land use plan. Then the BLM considers the social and economic aspects of the activity as well as its possible environmental impacts. The long-term health of the land guides all land use decisions. Another key part of the planning process involves working with local, state, and tribal governments; citizens; communities; and industry.

Your group can become familiar with the land use planning process by considering possible uses for a particular plot of open space on your school grounds or in your community. Follow the steps below to develop a land use plan and an activity plan for this space:

Step 1. Identify the issues: As a group, brainstorm possible uses for the land parcel. Keep in mind that you are planning for your community's present *and* future interests and needs. For instance, if you're planning for your school grounds, you should consider whether the school building itself might need to expand. Is your school likely to add more classrooms, a technology center, a science lab, or a gym? Will more space be required for parking or school buses? Create a list of possible uses for open space on your school grounds. The list might include outdoor play areas, a picnic area, a native plant garden, a pet play area, a swimming pool, a bird-watching area, or an area for solar panels. Consider putting your list on a bulletin board or the school's Web page. Invite everyone in the school community to review the list and tell you about issues they believe the plan should resolve. Encourage them to provide any information that could be useful to your planning group.

Step 2. Gather information: Visit the site, if possible, to map or make sketches and take photographs of the area. When preparing a land use plan, the BLM conducts an inventory of the resources in the area. Make note of the resources on your plot of land. For example, does it have plants and trees? Do any animals live there? Is there any water? Who owns the plot of land and the areas next to it? With help from your teacher, try to find out what laws and regulations affect the area. County or municipality websites might be a good place to start looking for this information. You could also consult with experts from your city's planning and zoning staff or your school district's facilities staff.

3. Create alternative approaches: Evaluate the present and future needs of your community, and brainstorm alternative ways of addressing these needs. Group them into themes, such as fitness (could include a tennis court, basketball court, skateboarding park, or swimming pool), conservation (could include solar panels, a native plant garden, or a bird-watching area), academic (could include a technology center, science labs, or additional classrooms), and an alternative that combines compatible uses.

4. Analyze the effects: A choice to use a particular parcel of land in one way often prevents using the land in other ways. Not every use can happen in the same place at the same time. Analyze the probable effects on other uses and land resources if the alternative approaches you identified in step 3 are implemented. Also consider some of the social aspects, such as how each approach will affect the people in the community. Address any economic aspects as well, such as how each approach will affect jobs, spending, and development in the community.

5. Choose the preferred approach: Based upon anticipated future needs, public input, and your analysis of the effects of implementing various alternatives, select the approach that you plan to implement. Remember that selecting one alternative eliminates the possibility of pursuing certain other uses. Your goal is to balance needs, demands, and effects and choose the best use of the land and its resources.

6. Implement your plan: After your plan is in place, pretend that you are approached by the school's tennis team with a proposal to build a tennis court in the open space on your school grounds. Describe the proposed action, the purpose of the action, and why it is needed. Assume that your school's championship tennis team must practice at a facility 10 miles away from the school and that the PTA has raised the money to build a tennis court complex at the school.

7. Determine whether the proposed activity is consistent with the entire land use plan: Is this activity allowed under the land use plan you developed? Is it consistent with the theme of the alternative you chose? Would building the tennis complex prevent other possible activities allowed in your land use plan? Where could the complex be built? Is the land undeveloped or would some other land uses have to be changed?

8. Assess how this specific proposed activity will affect the environment: What does the area look like now—flat, hilly, etc.? Would soil have to be removed or added? How would nearby waterways be affected by changes in drainage patterns? What plants and animals live in the area? Are any of these species protected by the Endangered Species Act? How would adjacent properties be affected? What other impacts would there be—more people? more traffic? more trash? Keep in mind that any construction project is likely to have short- and long-term impacts. If any of these impacts are harmful, what actions can be taken to reduce—or mitigate—the harm they cause? For example, could you relocate the complex or build a scaled-back version?

9. Prepare a draft activity plan and hold a public meeting: When the BLM produces an activity plan, it first issues the plan as a "Draft." The public is invited to provide additional facts—not opinions—about the plan. Public meetings are held in the area affected. Perhaps your class could present your plan to another group of students or parents, soliciting their comments on your proposal. Does your activity plan need to be changed based on these comments?

10. Finalize the activity plan: After incorporating public comments, the BLM issues a "Final Plan" and announces its proposed action. Make any necessary adjustments to your plan and then post your final "Record of Decision" on a bulletin board or the school's Web page.

11. Implement and monitor the activity plan: Once the BLM makes a decision about a particular use of the land, the next step is to put the plan into action. This involves more planning and scheduling and consultation with the public. The BLM continues to monitor the situation to make sure the plan is working as intended. If your school did build a tennis court complex on your school grounds, what kind of continued monitoring would need to take place?

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ENERGY ON PUBLIC LANDS

Evaluation Form

State: _____ **Grade Level:** _____ **Number of Students:** _____

1. Did you conduct the entire activity?	Yes	No
2. Were the instructions clear and easy to follow?	Yes	No
3. Did the activity meet your academic objectives?	Yes	No
4. Was the activity age appropriate?	Yes	No
5. Were the allotted times sufficient to conduct the activity?	Yes	No
6. Was the activity easy to use?	Yes	No
7. Was the preparation required acceptable for the activity?	Yes	No
8. Were the students interested and motivated?	Yes	No
9. Was the energy knowledge content age appropriate?	Yes	No
10. Would you use the activity again?	Yes	No

How would you rate the activity overall (excellent, good, fair, poor)?

How would your students rate the activity overall (excellent, good, fair, poor)?

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:

NEED Project
PO Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

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