

# Energy on Public Lands

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



## Grade Level:

**Int** Intermediate

## Subject Areas:



Science



Social Studies



Language Arts



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Rockford, MI

**Constance Beatty**  
Kankakee, IL

**Amy Constant**  
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NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration's Annual Energy Review that is published yearly. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at [www.eia.gov](http://www.eia.gov). EIA's Energy Kids site has great lessons and activities for students at [www.eia.gov/kids](http://www.eia.gov/kids).



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# Energy on Public Lands

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# Standards Correlation Information

[www.NEED.org/curriculumcorrelations](http://www.NEED.org/curriculumcorrelations)

## Next Generation Science Standards

- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations web site.

## Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations web site.

## Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED web site.

The screenshot shows the NEED website interface. At the top left is the NEED logo (National Energy Education Development Project) with social media icons for Facebook, Twitter, and LinkedIn. A search bar is located on the top right. A navigation menu includes: About NEED, Educators, Students, Partners, Signature Programs, State Programs, and Contact. The main content area shows a breadcrumb trail: Home > Educators > Supplemental Materials > Curriculum Correlations. The page title is "Curriculum Correlations". Below the title, a paragraph states: "NEED has correlated all of their materials to The Common Core State Standards for English/Language Arts and Mathematics. NEED has also correlated its materials to each state's individual science standards. All files are in Excel format. NEED recommends downloading the file to your computer for use. Save resources, don't print!". A list of links follows:
 

- [Common Core State Standards for English and Language Arts](#)
- [Common Core Standards for Mathematics](#)
- [Alabama](#)
- [Alaska](#)
- [Arizona](#)
- [Arkansas](#)
- [California](#)
- [Colorado](#)
- [Connecticut](#)
- [Delaware](#)
- [Florida](#)
- [Georgia](#)

 On the left side of the page, there is a sidebar menu with categories: Curriculum Resources, Professional Development, Evaluation, and Supplemental Materials. Under Supplemental Materials, there is a sub-menu with items like Curriculum Correlations, NEED Curriculum in Spanish, e-publications, Newsletters, Interactive Maps, Introduction to Nuclear Technology, Nuclear Energy, U.S. Energy Geography, U.S. Energy Geography Teacher Guide, Capturing Solar Energy, Capturing Solar Energy by Focusing, and Grid-tied Photovoltaic Panels.



# Teacher Guide

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.

## 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 while considering social, economic, and environmental factors.

## Objectives

- Students will be able to list different resources found on public lands in the United States.
- Students will be able to synthesize and analyze information on different maps and graphic organizers.
- Students will be able to list multiple uses for land and describe how each is important socially, economically, and environmentally.

## Preparation

- Familiarize yourself with the information and activities in the guide, and select the activities you will complete with students.
- Make copies of the informational text and maps for each student.
- Prepare copies of the maps on pages 21-23 for projection and discussion.

## Procedure

### 1. Introduction

- Introduce the students to the topic of public lands using the map on page 20. Emphasize the concept that these are lands held by the federal government for the benefit of all Americans.

### 2. History of Public Lands and the Role of BLM

- Have the students read the following sections of the informational text and complete the *Energy on Public Lands Graphic Organizer* on page 24: 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.

### 3. Energy Resources on Public Lands

- Have the students read the Energy Resources on Public Lands sections of the informational text and complete the *Energy Resources on Public Lands* graphic organizer on page 25. Discuss the various energy resources on public lands and their advantages and disadvantages.

### 4. Other Public Land Resources and Their Uses

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

### 5. BLM's Roles in Managing Energy Resources

- Have the students read BLM's Roles in Managing Energy Resources and the BLM: Balancing Multiple Uses sections of the informational text, and complete *Balancing Factors* and the *BLM Roles Graphic Organizer* on pages 26-27. Discuss the role BLM plays in assuring that public lands are managed in accordance with applicable laws.

### 6. Reinforcement of Knowledge

- Have the students complete the *Public Land Math* activity and *Key Vocabulary* worksheet on pages 28-29 to reinforce knowledge of the background material. See page 6 for answers.

## Grade Level

- Intermediate Grades 6–8

## Time

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

## 7. Maps Analysis and Critical Thinking

- Divide students into groups.
- Discuss as a class what is different about each map of public lands and what is similar.
- Direct students to copy of a standard geographical map of the United States with major cities and state boundaries.
- Ask students to pick a place they have been, a famous landmark, a city near them, etc., that is within or close to a parcel of public land.
- Students should write a description of the location they chose and how the public land it is on/nearby can affect it positively or negatively. How do people use/interact with the land or not use the land? What might be in that spot/surrounding area if the land parcel was not controlled by the BLM?

**NOTE:** You can pre-select landmarks or locations for students ahead of time, if necessary. Depending on your students, it may be helpful for them to allow for internet or library access to gather information about the locations they pick.

## 8. Land Use Planning Activity

- Divide students into groups.
- Explain that in this assignment, students will consider how a parcel of open land on the school grounds should be used.
- Have the students read the assignment on pages 30-31 and answer any questions they have. Give the groups a timeframe in which to complete the activity.
- 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.
- Ask the students to evaluate the activity—what did they learn and what additional information would be helpful to develop a more realistic plan.
- Evaluate student work using the rubric on the next page.

### Evaluation

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1. Evaluate the unit with students using the *Evaluation Form* on page 32 and send it to NEED.
2. Answers to *Public Land Math*:
  - Question 1—21.81 quads
  - Question 2—148.9 million barrels
  - Question 3—16.65 percent
3. A rubric for assessing student work on the planning activity is found on the next page. Evaluate student work using the rubric or one of your choice.



## Group Presentation Rubric

GRADE	CONTENT	ORGANIZATION	ORIGINALITY	WORKLOAD
4	Topic is covered in-depth with many details and examples. Subject knowledge is excellent.	Content is very well organized and presented in a logical sequence.	Presentation shows much original thought. Ideas are creative and inventive.	The workload is divided and shared equally by all members of the group.
3	Presentation includes essential information about the topic. Subject knowledge is good.	Content is logically organized.	Presentation shows some original thought. Work shows new ideas and insights.	The workload is divided and shared fairly equally by all group members, but workloads may vary.
2	Presentation includes essential information about the topic, but there are 1–2 factual errors.	Content is logically organized, but with a few confusing sections.	Presentation provides essential information, but there is little evidence of original thinking.	The workload is divided, but one person in the group did not do his/her fair share of the work.
1	Presentation includes minimal information or there are several factual errors.	There is no clear organizational structure, just a compilation of facts.	Presentation provides some essential information, but no original thought.	The workload is not divided, or several members are not doing their fair share of the work.



# Energy on Public Lands

## STUDENT INFORMATIONAL TEXT

### 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 national (federal) and state governments on behalf of all Americans.

The federal government owns about 640 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 247.3 million acres, mostly in the western states and Alaska. The BLM lands are often referred to as 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 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. Congress then established the General Land Office to oversee these tasks.

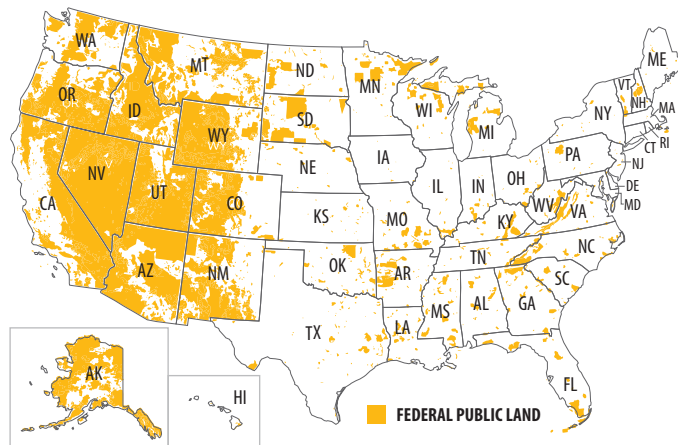
By the late 1800s, the public domain stretched from the Appalachian Mountains in the east to the Pacific Ocean in the west.

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 certain activities, such as mining and grazing, on the public lands. In 1934, Congress established the U.S. Grazing Service to manage the public rangelands.

### Federal Public Land Surfaces and Subsurfaces



Data: U.S. Department of the Interior, Bureau of Land Management

### 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 citizens and companies as well as protect the land and its 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 or remove these resources 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 revenue from 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 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. Over 70 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 2.4 billion barrels of oil a year. Almost six percent of this oil, or 133 million barrels, comes from federal lands. In 2013, companies competed to lease almost three million acres of BLM land in 28 states for oil or gas development. Most petroleum produced on public land in 2012 came from New Mexico, North Dakota, Wyoming, and Utah. These states account for 81% of the petroleum produced on BLM lands.

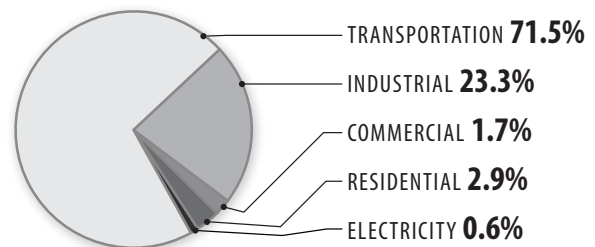
While no one can determine exactly how much oil might be available underground, geologists can make reasonably accurate estimates based on exploration data and current well production. Proved reserves of crude oil in the United States now exceed 33 billion barrels, and according to the Congressional Research Service, 5.3 billion barrels of that reserve amount are located on Federal public land. Another 5.4 billion barrels are beneath offshore locations administered by Federal agencies. The cost of obtaining leases to produce petroleum on Federal land and other factors may limit the amount of petroleum actually produced on public land in the future.

Once crude oil is found and taken from the ground, it moves through pipelines or is transported by truck or ship 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 to its natural condition or better. 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.

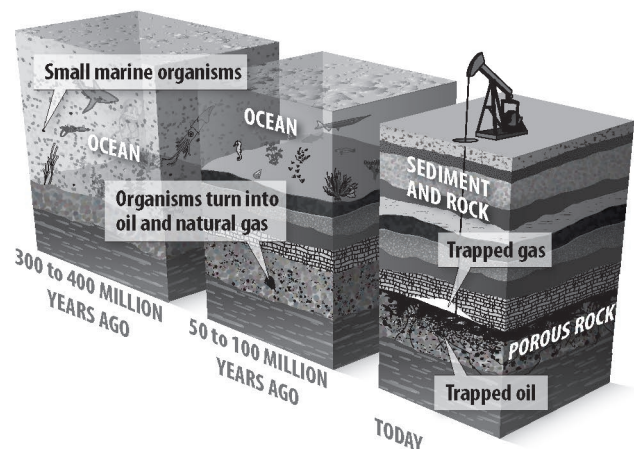
Petroleum is an important fuel in our society, but its use has drawbacks. Petroleum can pollute the air and water when it is burned. If not properly managed, drilling for oil can cause damage to fragile environments.

### U.S. Petroleum Consumption by Sector, 2012



Data: Energy Information Administration

### How Petroleum and Natural Gas Were Formed



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over hundreds of millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

## ▪ Natural Gas

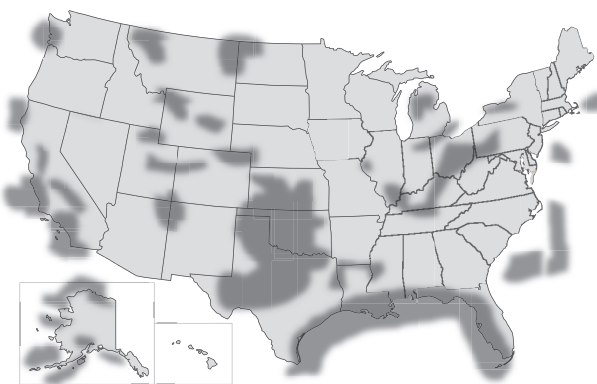
Natural gas often occurs near petroleum in rock formations. Natural gas is produced from the ground and moved through pipelines around the country. Methane, which is the main ingredient in natural gas, is colorless and odorless. A gas called mercaptan, which can smell like rotten eggs, is added to natural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

Natural gas can be found onshore, or under land, as well as offshore locations, which are beneath land at the bottom of oceans. Eighty-five trillion cubic feet of natural gas are in proved reserves beneath federal lands, which is slightly more than a quarter of all the natural gas reserves in the United States. The amount of natural gas being produced on federal land has been decreasing slightly because most of the areas of new exploration and production of natural gas are located in areas not administered by federal agencies. In 2012, production on federal land accounted for 17% of all natural gas produced in the United States.

Natural gas is used for electricity generation, industrial production, and for heating businesses and homes. It is also used 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.

## U.S. Oil and Gas Basins

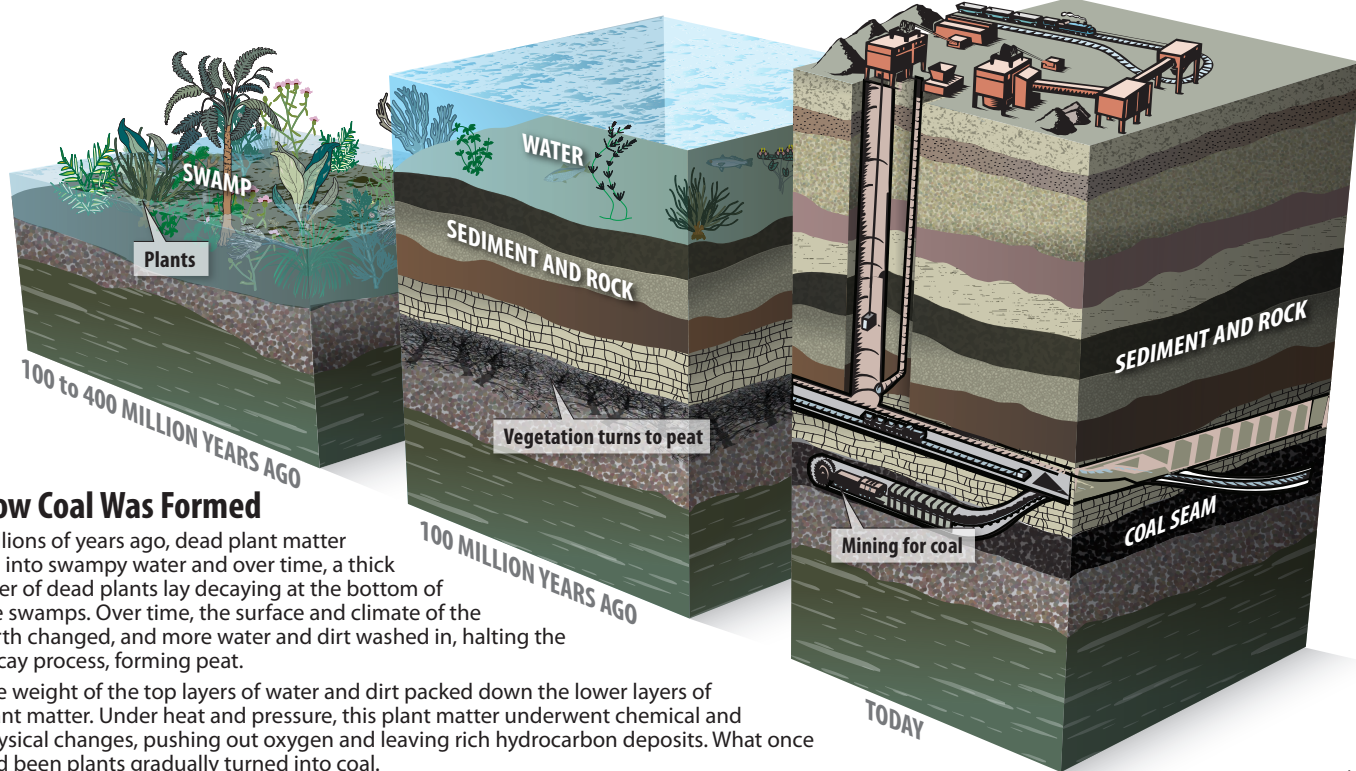


Data: Energy Information Administration

## ▪ 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



### How Coal Was Formed

Millions of years ago, dead plant matter fell into swampy water and over time, a thick layer of dead plants lay decaying at the bottom of the swamps. Over time, the surface and climate of the Earth changed, and more water and dirt washed in, halting the decay process, forming peat.

The weight of the top layers of water and dirt packed down the lower layers of plant matter. Under heat and pressure, this plant matter underwent chemical and physical changes, pushing out oxygen and leaving rich hydrocarbon deposits. What once had been plants gradually turned into coal.

Coal can be found deep underground (as shown in this graphic), or it can be found near the surface.

Note: not to scale



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 in the United States. Sometimes river barges and trucks also 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 a greenhouse gas. These gases in the atmosphere, like a greenhouse, trap energy from the sun, causing a rise in the Earth's temperature. Sulfur can mix with oxygen in the atmosphere 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 to mine coal with a low sulfur content. Power plants that burn coal must install scrubbers, which are devices that remove most of the sulfur from coal smoke.

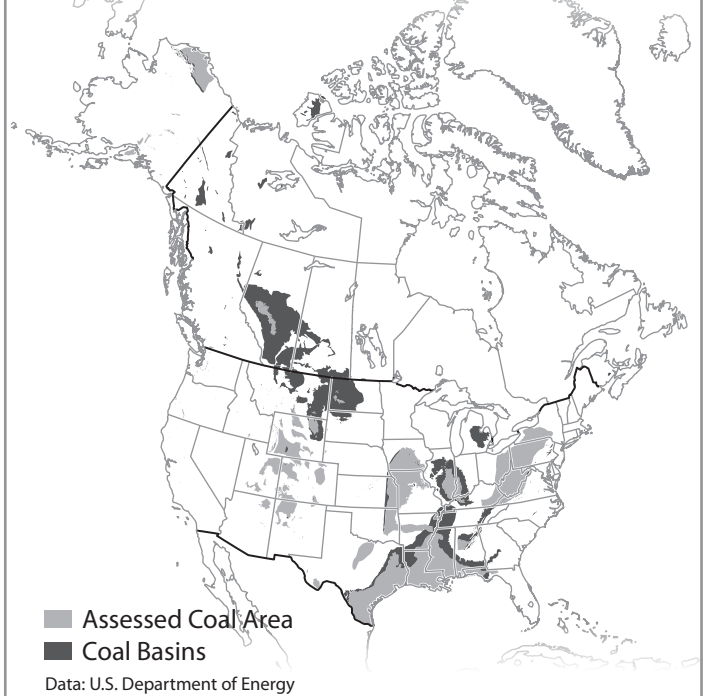
Coal reserves are beds of coal that have not yet been mined. The United States has the world's largest known coal reserves, many of which are under federal lands. Americans use about 889 million short tons of coal a year. One short ton equals 2,000 pounds. About 401 million short tons, or 45 percent, come from under federal lands. Coal provides approximately 37 percent of the electricity and just over 18 percent of the total energy consumed in the United States. In fact, about 90 percent of the coal that is mined is used to generate electricity.

The BLM does not mine coal. Private companies conduct the mining operations. A company must obtain a lease from the BLM to mine coal on any parcel of federal land. Currently, there are 308 leases that have been issued to companies seeking to mine coal on federal land. Not all of these leases are currently being used to actually produce coal.

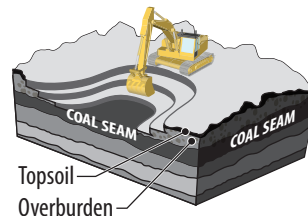
## COAL MINERS



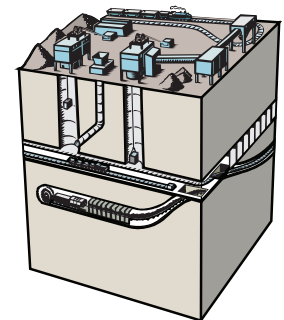
## Coal Basins and Assessed Areas



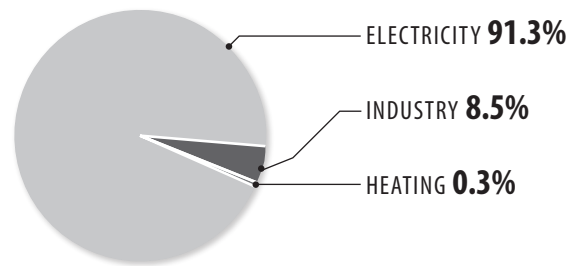
### Surface Mining



### Deep Mining



## U.S. Coal Consumption by Sector, 2012



Data: Energy Information Administration

## Renewable Energy Resources

Renewable energy sources are resources that can be replenished in a short period of time, such as wind and solar energy. Renewable energy projects underway on public lands are administered by the BLM as well as the U.S. Department of the Interior, and include wind, solar, geothermal, and biomass resources.

### ▪ Wind

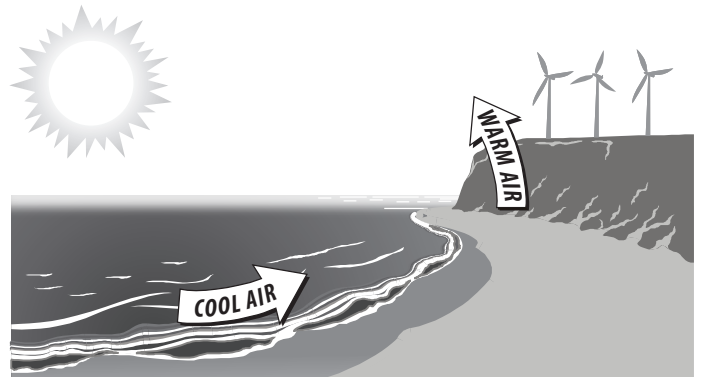
Wind is simply air in motion. It is produced by the uneven heating of the Earth's surface by energy from the sun. Since the Earth's surface is made of very different types of land and water, it absorbs the sun's radiant energy at different rates. For example, on the coast during the day, land heats up more quickly than the water. The warm air over the land expands and rises as cooler air over the water moves in to take its place, creating a convection current, or wind.

Large atmospheric winds that circle the Earth are produced because the Earth's surface near the Equator receives more of the sun's energy than the surface near the North and South Poles.

Wind is called a renewable energy source because wind will continually be produced as long as the sun shines on the Earth. The ancient Egyptians used wind power to sail their ships on the Nile River. Later, wind power was used to grind grain in windmills. American colonists used windmills to grind wheat and corn, pump water, and cut wood. Rural areas that did not have electric service in the 1920s used small windmills to generate electricity. Today, wind energy is mainly used to generate electricity and transmit it across the country.

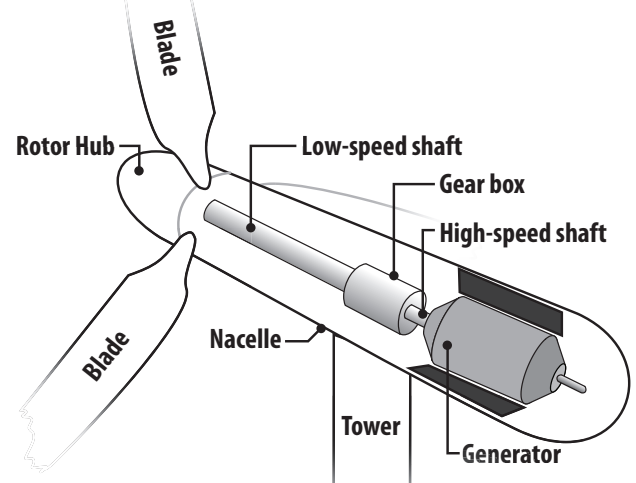
Generating electricity with wind energy uses a machine called a wind turbine. The size, location, and wind speed reaching the turbine all factor into determining how much electricity a turbine can produce. Turbines have blades, which are pushed by the wind. The blades are attached to the turbine by a hub, which changes the linear motion of the wind into rotational motion within the turbine.

## How Wind is Formed

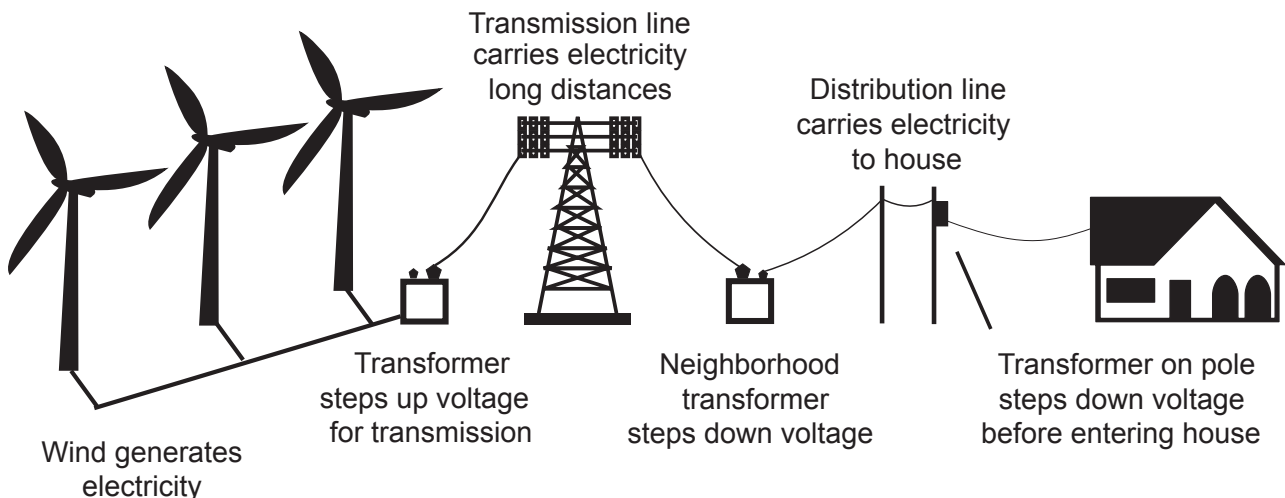


1. The sun shines on land and water.
2. Land heats up faster than water.
3. Warm air over the land rises.
4. Cool air over the water moves in.

## Wind Turbine Diagram



## Transporting Wind Energy



Inside the turbine, the low-speed spinning of the hub is changed to a higher speed with gears in a gear box. The faster spinning gears turn a generator inside the hub, which produces electricity. Before the electricity makes it to the electric power grid, the voltage of the current is increased with a transformer.

Wind turbines can be installed in groups that work together to produce large amounts of electricity. These groupings, called wind farms, are situated where wind speeds will be adequate to justify the cost of constructing them and where they are accessible by technicians sent to maintain or repair them. Other considerations in siting a wind farm include the local weather conditions year-round and the location relative to the power grid. Laying long-distance power lines to transmit power from a remote wind farm can be very expensive. Some wind farms are placed on multi-use land, where another activity, like grazing or mining, takes place.

Some wind farms are being constructed offshore in shallow water where there is consistent wind speed much of the time. The wind blows stronger and steadier over water than land. There are no obstacles on the water to block the wind. While offshore turbines typically produce more electricity than turbines on land, they cost more to build and operate. Furthermore, the cables that carry the electricity must be buried deep under the water's surface.

Wind energy is clean and its energy source is free, but there are some drawbacks to using wind energy. Some wind turbines may have a negative effect on wild bat populations, and wind turbines change the appearance of the landscape. Many people do not like the look of wind turbines, while others feel they are a beautiful alternative to conventional power plants that burn coal or natural gas.

Of all the land in the U.S. with potential for development for wind energy, 20.6 million acres fall under the jurisdiction of the BLM. Thirty-nine projects with a total capacity of over 5,000 megawatts have been permitted on public land, with an additional 100 authorized wind testing sites. The power produced by these projects can provide the needs of over 1.5 million households. Another 29 development applications are pending approval by BLM.

All of the approved BLM wind energy projects are located in Arizona, California, Idaho, Nevada, Oregon, Utah, and Wyoming. Two of the projects that are currently pending approval would be located in California. If approved, these two projects would add 130 megawatts to the maximum generating capacity on public lands.

## ■ Solar

Solar energy is radiant energy that is produced by the sun. Every day the sun radiates, or sends out, an enormous amount of energy. The sun radiates more energy in one day than the world uses in one year. Only a small portion of the energy radiated by the sun into space strikes the Earth, one part in two billion. Solar energy is used two ways: heating spaces and water; and generating electricity.

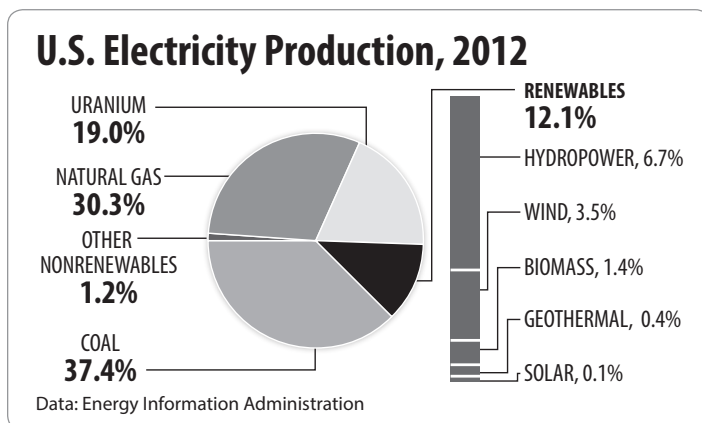
Heating with solar energy is not as easy as you might think. Capturing sunlight and putting it to work is difficult because the solar energy that reaches the Earth is spread out over such a large area. The sun does not deliver that much energy to any one place at any one time. How much solar energy a place receives depends on several conditions. These include the time of day, the season of the year, the latitude of the area, and the cloudiness of the sky.

A solar collector is one way to collect heat from the sun. A closed car on a sunny day is like a solar collector. As sunlight passes through the car's glass windows, it is absorbed by the interior of the car. The light that is absorbed changes into heat. The car's glass windows let light in, but don't let all the heat out.

Today, many homes use solar energy for space heating. There are two general types of solar space heating systems: passive and active. Hybrid solar systems are a combination of passive and active systems. In a passive solar home, the whole house operates as a solar collector. A passive house does not use any special mechanical equipment to transfer the heat that the house collects on sunny days. Unlike a passive solar home, an active solar home uses mechanical equipment, such as pumps and blowers, and an outside source of energy to help heat the house when solar energy is not enough. The visitor center in Zion National Park in Utah uses solar energy to heat its interior as well as to generate electricity.

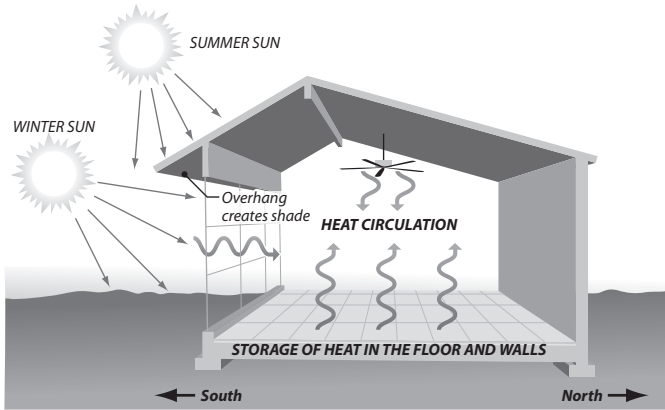
Solar energy is also used to heat water by using a modified solar collector with a heat exchanger. This heat exchanger is filled with fluid that snakes back and forth inside the collector. The heated fluid then circulates through pipes in the hot water tank to heat the water.

There are two ways to generate electricity from solar energy: solar thermal systems; and photovoltaics. The word photovoltaic comes from the words *photo*, meaning "light", and *volt*, a measurement of electricity. Sometimes photovoltaic cells are called PV cells or solar cells for short. The cost per kilowatt-hour to produce electricity from PV cells can sometimes be as much as three times as expensive as from conventional sources. However, PV cells make sense for many uses today, such as providing power in remote areas or other areas where electricity is difficult to provide. On North Manitou Island in Sleeping Bear Dunes National Lakeshore, hikers and campers were forced to endure the noise of the island's diesel generators until the U.S. Department of the Interior installed a PV system. Now, 85 percent of the island's electricity is generated using solar energy, with the other 15 percent coming from the diesel generators.





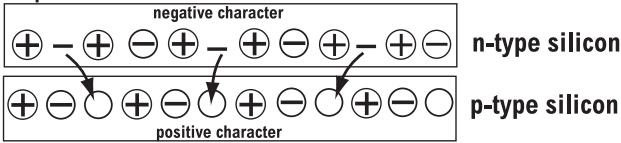
## Passive Solar Home Design



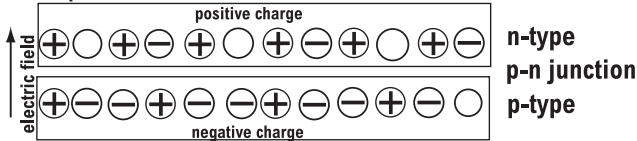
## Photovoltaic Cell

○	A location that can accept an electron
—	Free electron
⊕	Proton
⊖	Tightly-held electron

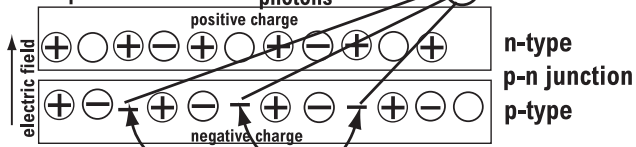
Step 1



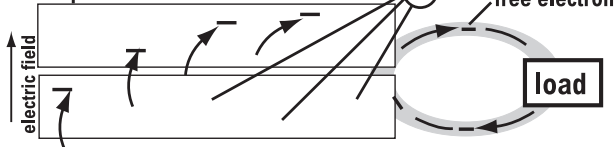
Step 2



Step 3



Step 4



Like solar cells, solar thermal systems use solar energy to make electricity. Concentrated solar power (CSP) technologies focus heat in one area to produce the high temperatures required to make electricity. The high temperature is then used to generate steam to turn a turbine, just as is the case in any other thermal power plant powered by a fossil fuel.

Using solar energy produces no air or water pollution, and it is a free and widely available energy source. Manufacturing the photovoltaic cells to harness that energy, however, consumes silicon and produces some waste products. In addition, large solar thermal farms can harm desert ecosystems if not properly managed.

Because the Southwest receives some of the most intense solar radiation in the world, it is a prime location for utilizing solar energy. The BLM has seventeen solar projects currently in operation or under construction, all in California or Nevada. Most of these are photovoltaic sites, with 939 MW current generating capacity and an additional 2,450 MW under construction and scheduled to open within the next two years. The five CSP plants either currently operating or being constructed have a combined generating capacity of 1,130 MW. In 2012 the Department of the Interior established seventeen solar energy zones designed to encourage more utility-scale solar power development in California, Nevada, Arizona, Colorado, Utah, and New Mexico.

### LINEAR FRESNEL REFLECTORS - A CSP SYSTEM



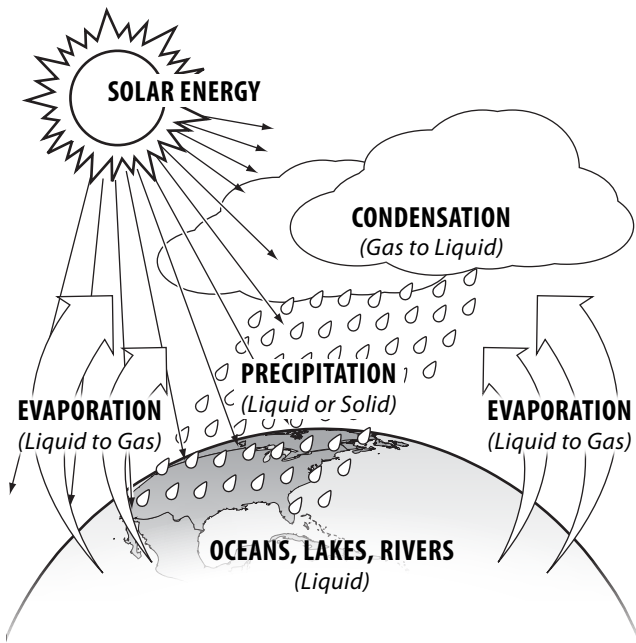
Photo courtesy of National Renewable Energy Laboratory

### SOLAR WATER HEATER





## The Water Cycle



## 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.

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.

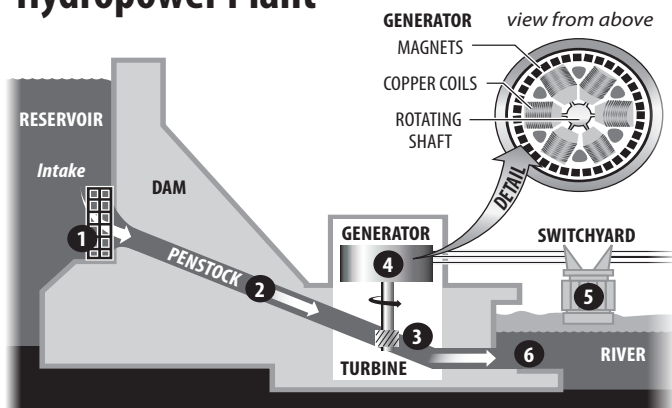
Another way to use water to produce electricity is to build a dam. A dam can be built on a river, stopping the flow of water and creating a lake or reservoir behind it. When water is allowed through the dam, the force of the falling water spins the blades of a turbine to produce electricity. With dams, 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.

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 habitats under water. Dams can also cause upstream flooding and deplete downstream flows.

Currently, hydropower generates five to ten percent of America's electricity, depending on rainfall. Hydropower facilities located in areas experiencing drought will have less generating capability than those supplied with normal or above normal rainfall. Three states, Washington, Oregon, and Idaho, rely on hydropower for at least 75 percent of their electricity needs. There are 480 hydropower projects associated with BLM lands. Because most optimal locations for hydropower are already being used, the U.S. Department of the Interior and BLM are now focusing attention on developing non-hydro renewable energy resources on public lands. The majority of existing federal hydropower generating facilities are owned and operated by the Bureau of Reclamation or the U.S. Army Corps of Engineers.

## Hydropower Plant



1. Water in a reservoir behind a hydropower dam flows through an intake screen, which filters out large debris, but allows smaller fish to pass through.
2. The water travels through a large pipe, called a penstock.
3. The force of the water spins a turbine at a low speed, allowing fish to pass through unharmed.
4. Inside the generator, the shaft spins coils of copper wire inside a ring of magnets. This creates an electric field, producing electricity.
5. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.
6. Water flows out of the penstock into the downstream river.

## ▪ 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.

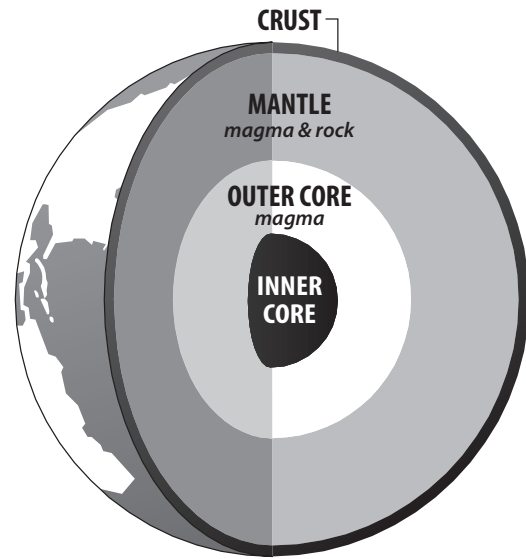
The core of the Earth is made up of magma, and the mantle is made up of magma and rock. The outermost layer of the Earth is called the crust. The crust forms the continents and the ocean floor. This layer is not a solid piece. It is broken into plates. Hot magma comes close to the Earth's surface near the edges of these plates. Deep underground, rocks and water absorb heat from the magma. This heat can be collected by drilling 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.

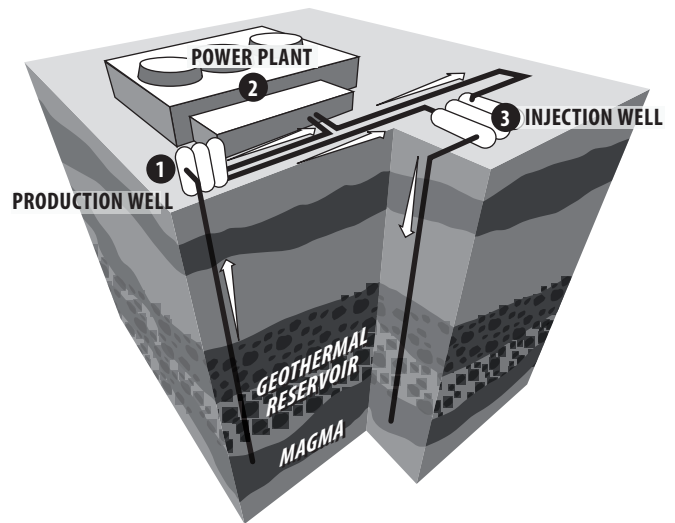
Most geothermal resources are in the western United States because of the structure of the North American continental plate. Many of the best sites for potential geothermal development are on BLM-managed land. About 40 percent of all electricity generated from geothermal resources is done on public lands. All of the geothermal land leases administered by the BLM are located in Colorado, Utah, Nevada, and California.

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.

## The Earth's Interior



## Geothermal Power Plant



- 1. Production Well:** Geothermal fluids, such as hot water and steam, are brought to the surface and piped into the power plant.
- 2. Power Plant:** Inside the power plant, the geothermal fluid turns the turbine blades, which spins a shaft, which spins magnets inside a large coil of wire to generate electricity.
- 3. Injection Well:** Used geothermal fluids are returned to the reservoir.

## ■ 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 about 2% 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. Seventy-five waste-to-energy plants used 29 million tons of municipal solid waste to generate electricity in 2011. 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.

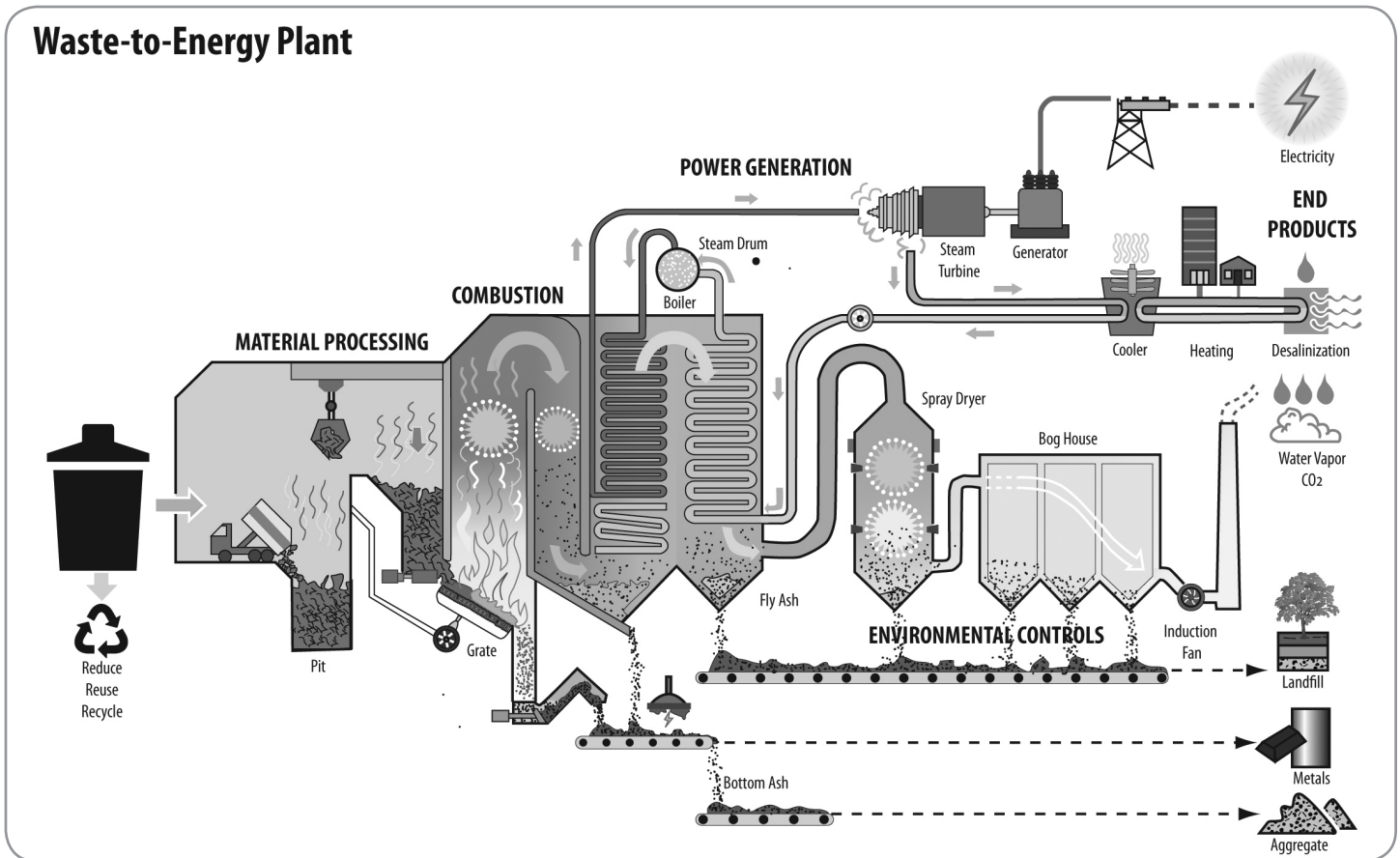
A second way biomass can be used is through bacterial decay. Bacteria feed on dead plants and animals and produce a gas called methane. Methane is a good source of energy. It can be burned to produce heat or electricity. Landfills produce methane. Some have systems that can capture it and use it as an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

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 1.42 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. Thinning projects remove excess biomass from forests in order to meet healthy forest objectives and to help prevent the spread of forest fires. This excess organic material--trees, branches, shrubs, and other plants--can be taken to a facility to be burned to produce electricity. The BLM estimates that forest resources on public and private lands could produce as many as 368 million tons of biomass each year. The BLM has several projects designed to increase the use of biomass, including heating a building in Alaska, generating electricity along with coal in Colorado, and developing local renewable power in Oregon.

## Waste-to-Energy Plant





In addition to thinning projects, the BLM also provides biomass from areas where invasive plant material is removed from public lands. Several BLM projects on the Modoc Plateau in California have been removing invasive Juniper trees in order to allow the growth of native plants, such as sage-brush and grasses, that are important to the survival of area wildlife. The invasive trees are cut down, chipped on site, and sent to nearby bioenergy and cogeneration facilities. These facilities often use a combination of wood/geothermal or wood/coal resources to produce 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

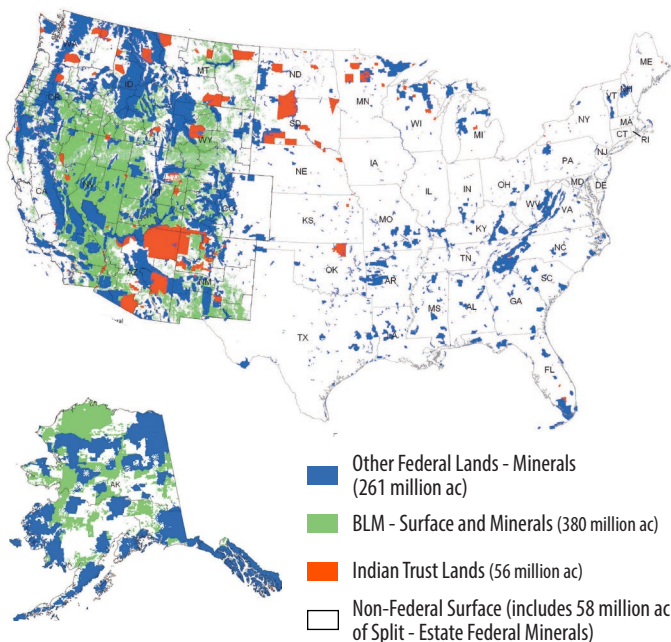
Another of the BLM's roles is to authorize every use of the land. While the BLM does not remove any energy resources, it does grant permits to private companies to explore and develop the resources. Once a company has been awarded a lease, it must obtain permits from the BLM and all other agencies that 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, nearly 20,000 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 turbines 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.

## Public Lands, On-shore Federal and Indian Minerals in the U.S.

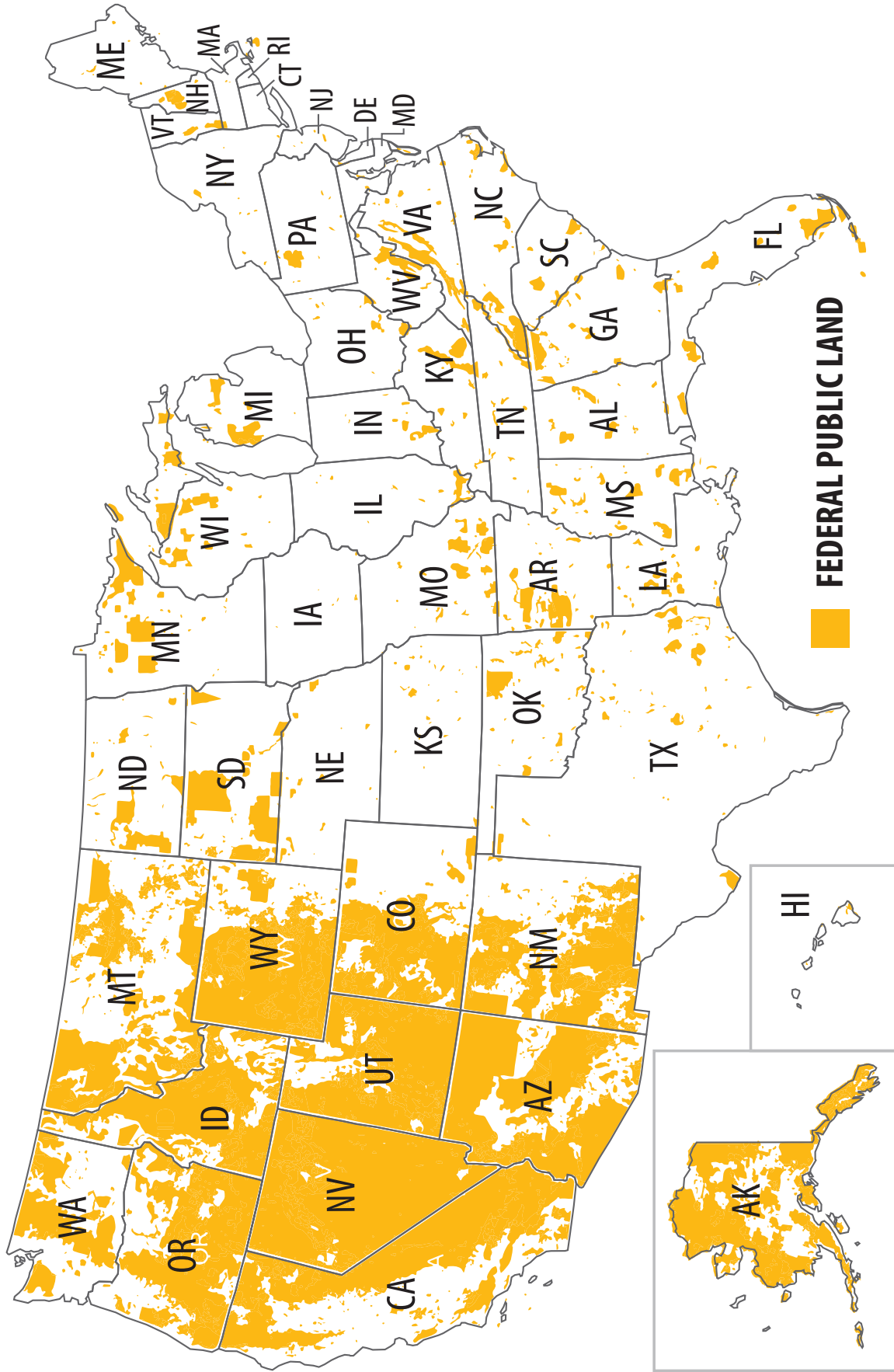


Data: U.S. Department of the Interior, Bureau of Land Management





# Bureau of Land Management Public Lands

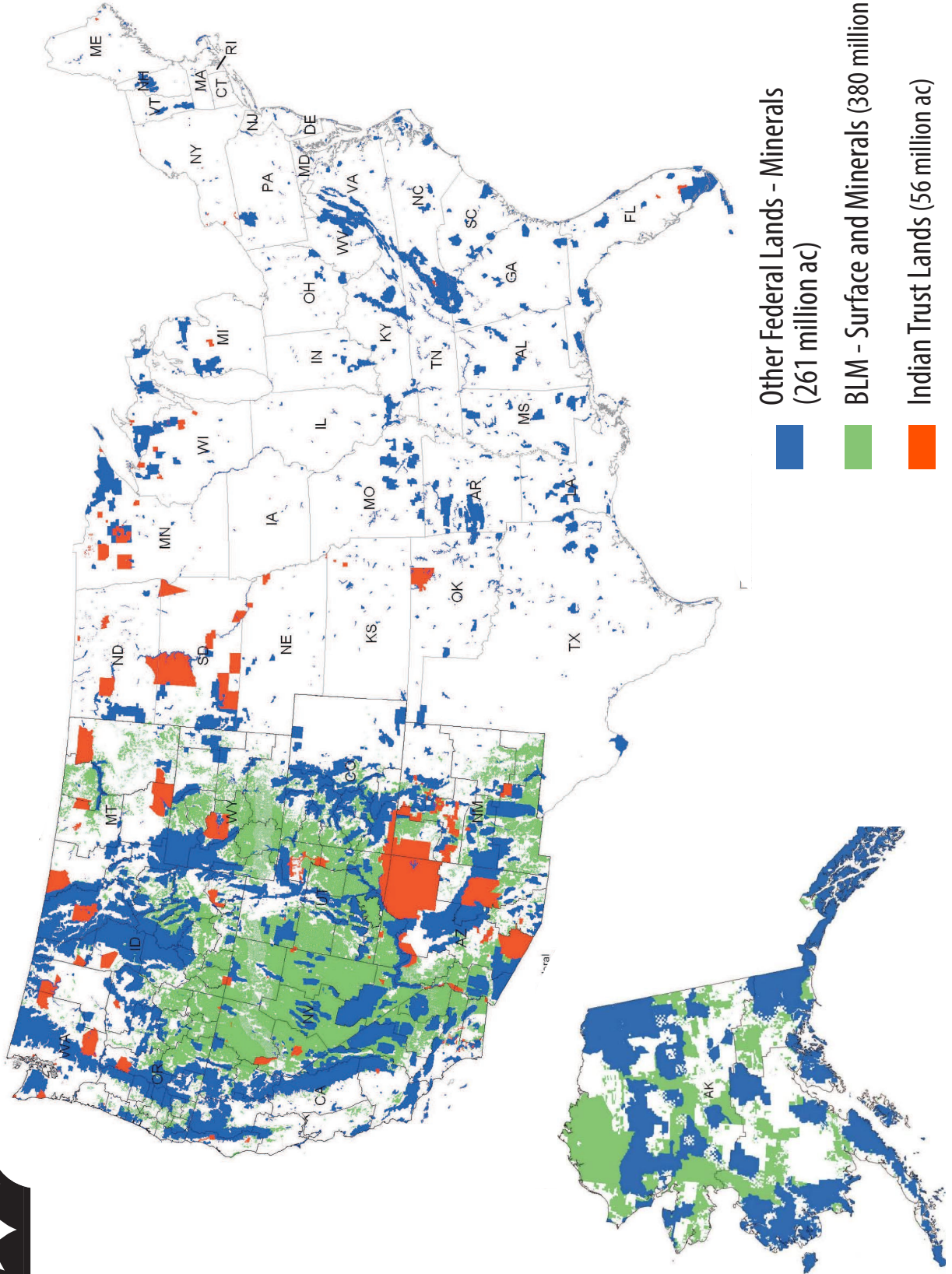


Data: U.S. Department of the Interior, Bureau of Land Management





# On-shore Federal and Indian Minerals in the U.S.



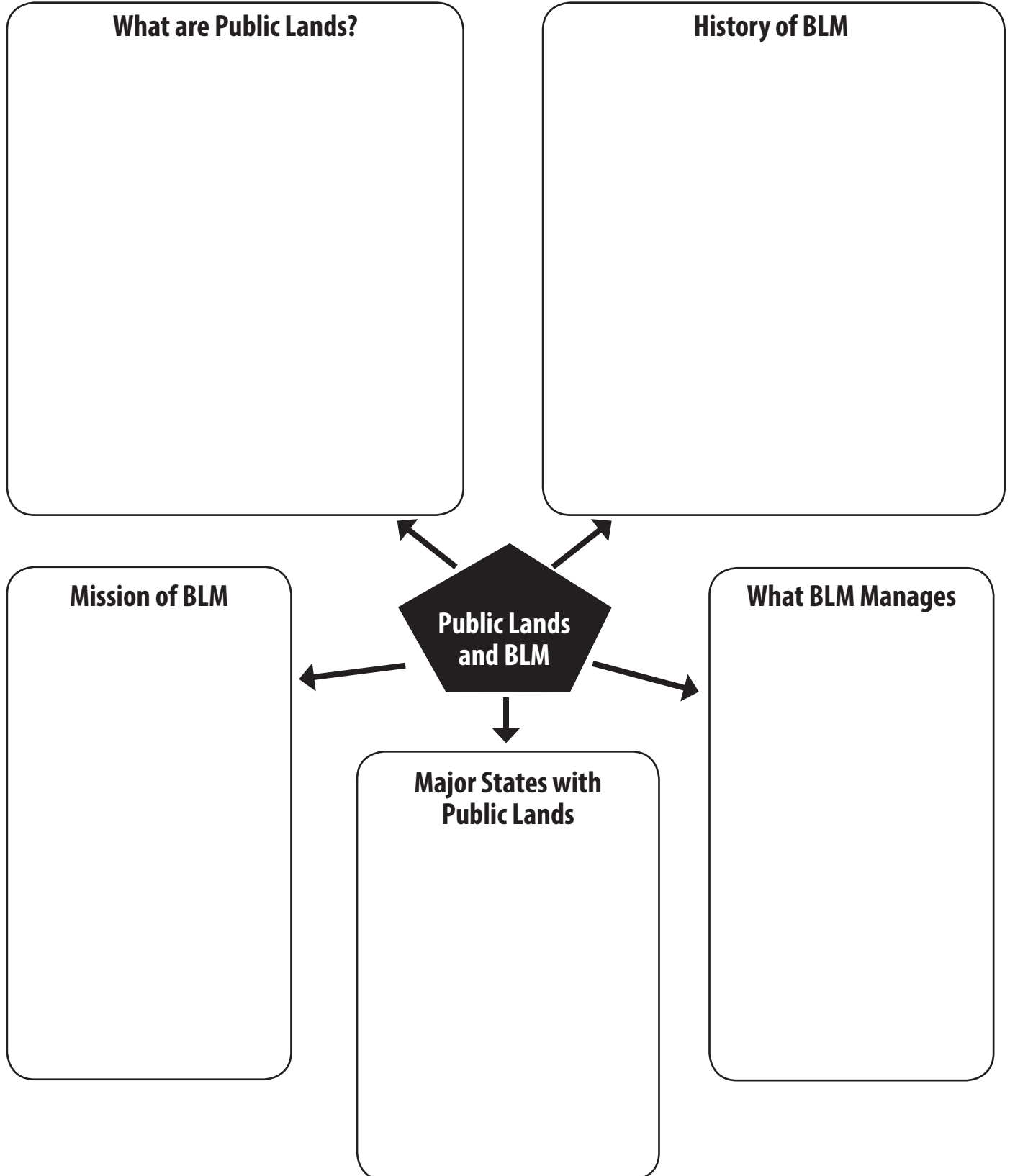
Data: U.S. Department of the Interior, Bureau of Land Management







# Energy on Public Lands Graphic Organizer





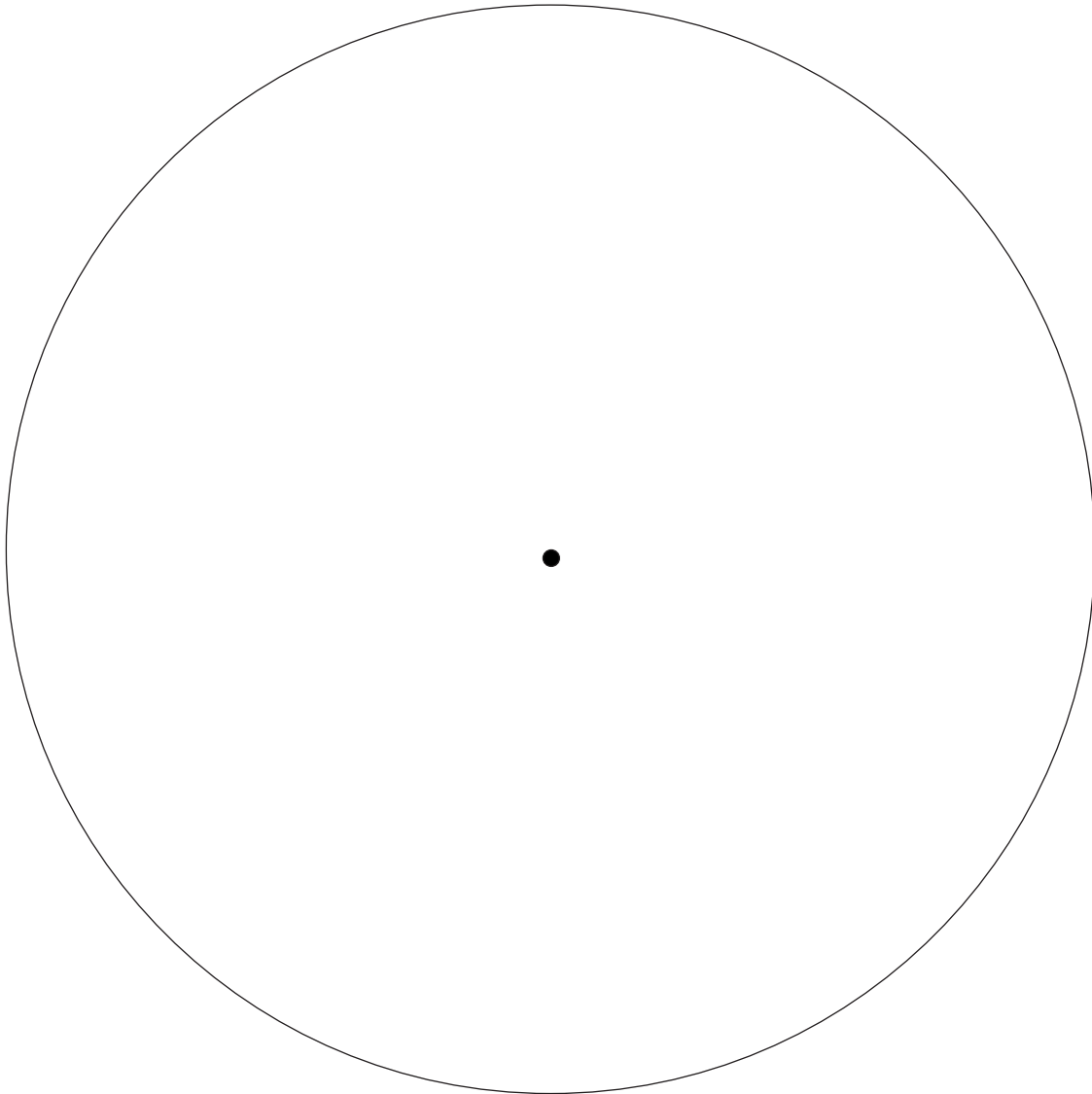
# Energy Resources on Public Lands

Energy Resources	Formation	Important Facts—Advantages and Disadvantages



# Balancing Factors

Make a pie chart that shows the three factors (social, economic, and environmental impacts) 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.

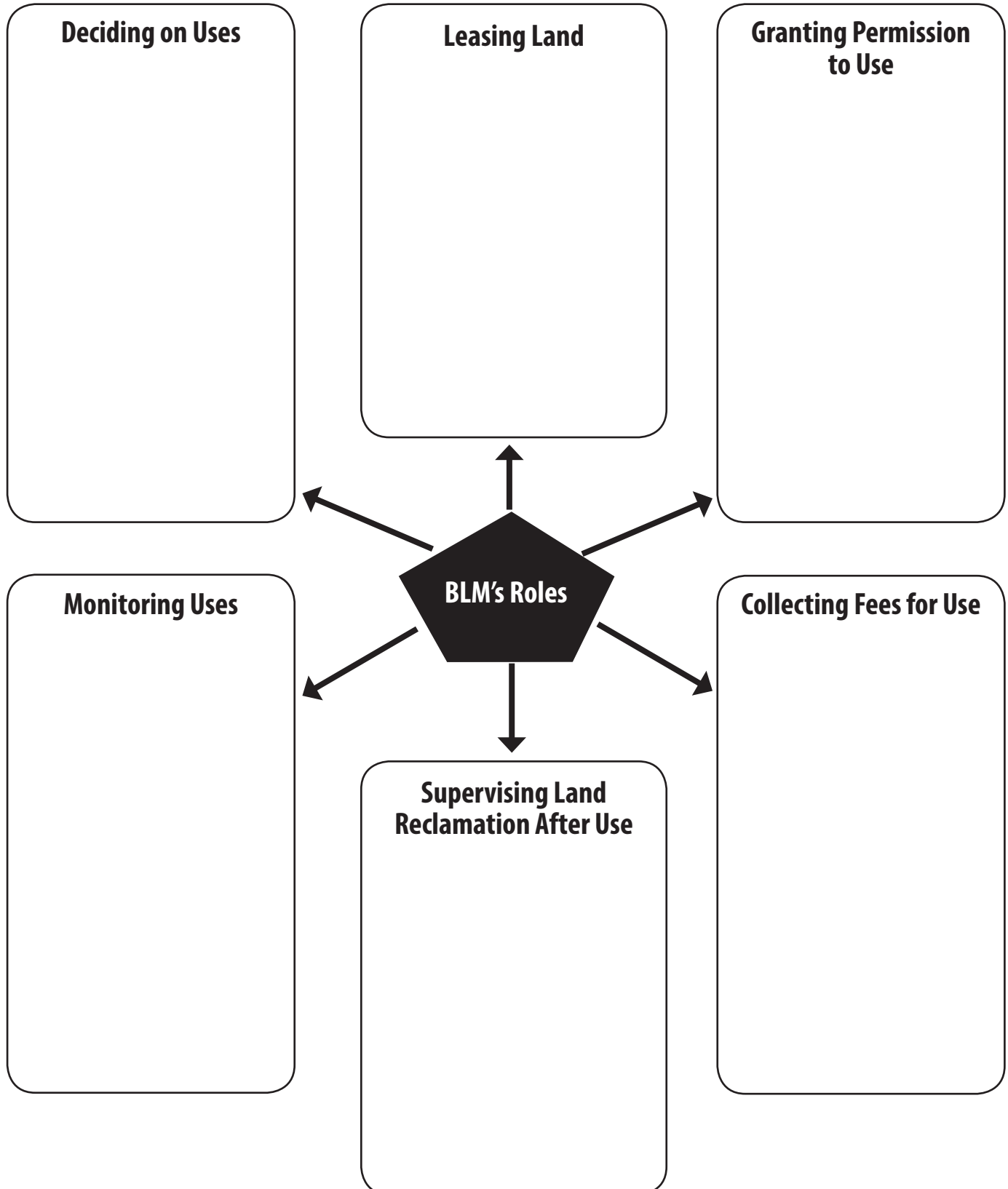


**\*\*Explanation**

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# BLM Roles Graphic Organizer









# Key Vocabulary

Define the following words found in the background information.

1. Public Lands
2. Mineral Rights
3. Fluid Minerals
4. Solid Minerals
5. Royalty
6. Bonus
7. Rent
8. Right of Way
9. Fossil Fuel
10. Surface Mining
11. Underground Mining
12. Reserve
13. Lease



# Land Use Planning Activity

## Introduction

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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

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**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 group.

## Step 2

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**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.

## Step 3

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**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.

## Step 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.

## Step 5

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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.

## Step 6

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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.

## Step 7

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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?

## Step 8

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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?

## Step 9

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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?

## Step 10

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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.

## Step 11

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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?





# Energy on Public Lands Evaluation Form

State: \_\_\_\_\_ Grade Level: \_\_\_\_\_ Number of Students: \_\_\_\_\_

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

*Please explain any 'no' statement below.*

How would you rate the unit overall?  excellent  good  fair  poor

How would your students rate the unit overall?  excellent  good  fair  poor

What would make the unit more useful to you?

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Other Comments:

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Please fax or mail to: **The NEED Project**  
P.O. Box 10101  
Manassas, VA 20108  
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