Get That Gasoline

Students sequence career titles of those responsible for oil extraction and refining to learn what is involved in getting gasoline for automobiles.

Grade Level: 5–8

Subject Areas: English Language Arts, Family and Consumer Science, Mathematics, Science

Setting: Classroom

Time:
Preparation: 30 minutes
Activity: 50 minutes

Vocabulary: Cracking, Drilling mud, Drilling rig, Fractional distillation, Hydrocarbon, Petroleum, Refinery (See the ***Oil Production Career Cards*** for titles and definitions of careers used in this activity)

Major Concept Areas:

- Development of energy resources
- Management of energy resource use

Getting Ready: After the sets of cards are copied and cut out, you may want to laminate them for durability.

Objectives

Students will be able to:

- organize career titles of people involved in oil extraction and refining;
- describe what is involved in getting oil from the well to the car; and
- appreciate that any energy resource they use is made available by the work of many people.

Rationale

Introducing students to careers involving oil extraction and refinement helps them appreciate the number of people required to produce gasoline and other energy resources and increases their awareness of other energy-related occupations.

Materials

- A set of ***Oil Production Career Cards*** for each group of students
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Background

You're driving to work when you notice your gas tank is running low. You turn into a gas station, and within 15 minutes, your car is full of gasoline and you're on your way. But do you really know how much time and energy was involved in getting that gasoline? Many activities are involved in making gasoline available for our use. Accomplishing these activities requires the work of thousands of people working in different careers related to oil extraction and refining.

The first step in oil production is finding crude oil (or liquid petroleum), which is often buried deep underground. Advanced technology helps geologists and geophysicists determine which underground areas most likely contain crude oil. To locate underground materials that may contain crude oil, geologists and geophysicists survey Earth with devices such as gravity meters, magnetometers, and seismographs (see **Exploring for Oil**).

Oil is not found in underground lakes, as people commonly suppose. Instead, oil is trapped in rocks with holes like sponges. Natural gas is dissolved in the oil, or separates and rests atop the oil as a separate layer. Even with modern technology, the search for oil is fraught with uncertainty. The chance of striking oil in a new location is only about ten percent. And even when oil is found, there is rarely enough to make

production commercially viable. If an underground formation has a good chance of yielding oil, then exploratory drilling is done. Drilling a test well is the only way to know for sure whether or not the oil is in that particular location.

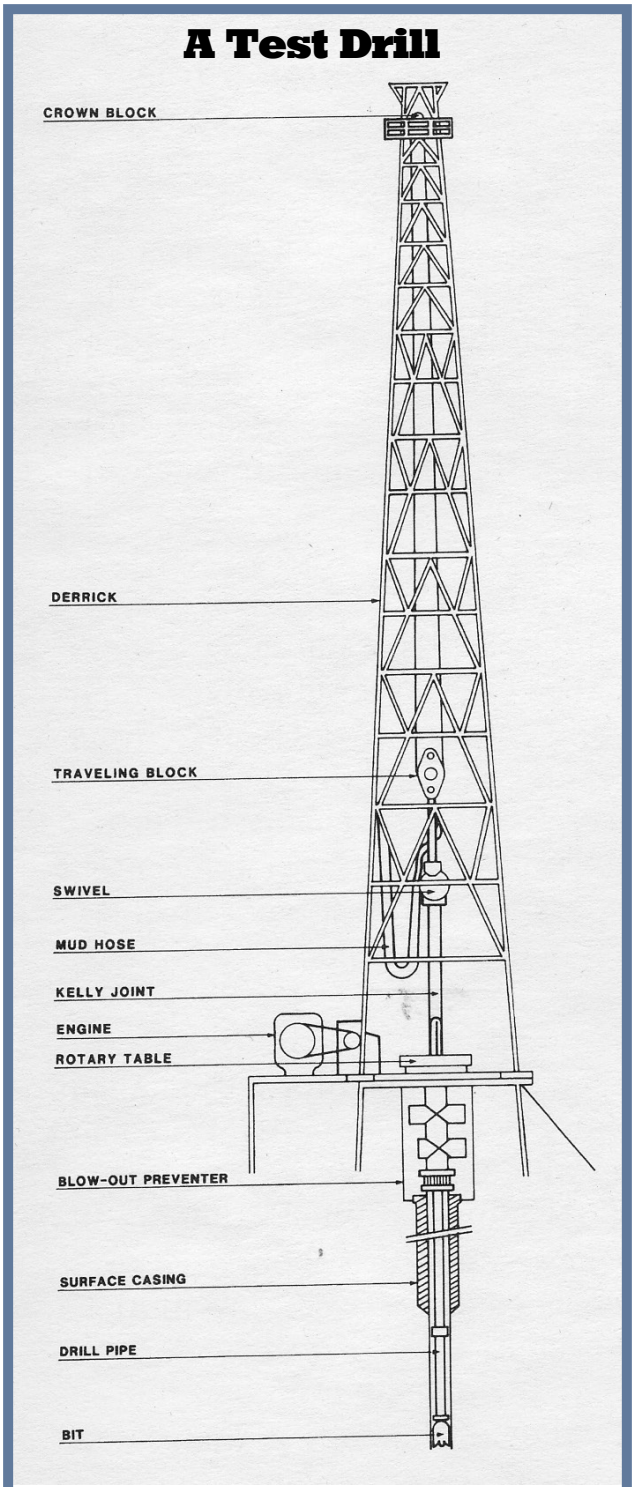
Before drilling can start, a person must obtain permission to use the land, whether it is a desert, farmland, a park, or a forest. Private owners, governments, and conservationists may have to be consulted. A landman obtains permission to drill on privately-owned land. Companies must also seek permission to drill in the sea.

Once permission is obtained, the test well is drilled with a drilling rig. An oil drilling rig works somewhat like a huge electric drill. It drills through rock for hundreds and sometimes thousands of feet. Unlike an electric drill, the oil rig must constantly have extensions put onto the bit so that it can go deeper and deeper into the rock. A special mixture of clay, chemicals, and water (called drilling mud) is pumped down the well through the pipe and emerges out of nozzles in the bit.

Many people are involved in operating and maintaining an oil drilling rig (see ***Oil Production Career Cards*** for descriptions of a few of these occupations). These people include the drilling supervisor, who oversees the operation of the rig, a team of maintenance workers called rotary helpers (or "roughnecks"), and roustabouts. In addition, environmental engineers carefully monitor this operation as well as all other stages of oil production to make sure environmental and safety regulations are met (see **A Test Drill**).

Crude oil that comes from the ground is not ready to be pumped into your car. First it needs to be refined. And before it can be refined, the oil needs to get to the refinery. One method by which oil travels to refineries is through pipelines (other ways include barges and oil tankers). In 2014, the United States alone had about 161,000 miles of pipeline (crude and product), with pumping stations at regular intervals that keep the oil moving at about 5 miles per hour (8 km/hr). Some pipelines are over a thousand miles long. The longest oil pipeline in the world runs 2,353 miles (3,787 km) from Edmonton, Canada through Chicago to Montreal, Canada. See ***Facts about Oil***.

As with other steps of oil production, the step of building and maintaining pipelines requires many people. Civil



Source: American Petroleum Institute. *Petroleum Exploration: Continuing Need*. Used by permission. All rights reserved.

engineers design the pipelines, and a construction crew (with ditching machine operators and welders) builds them. A series of scientists, engineers, technicians, and managers work together to process oil into usable products at the refinery. A petroleum refinery contains a tall tower called a fractionating tower or column, where crude oil is boiled and separated into "fractions"—mixtures of hydrocarbons that boil at temperatures in a given range. (Hydrocarbons are molecules composed of hydrogen and carbon elements; different types of hydrocarbons have varying amounts and arrangements of these elements.) In general, hydrocarbons with more carbon atoms have higher boiling points. Through this process of "fractional distillation," the hydrocarbons in crude oil are separated on the basis of their differing boiling points (see **A Fractioning Tower**).

Distillation alone will not produce the quantities of gasoline needed, so some of the other distilled products are converted into gasoline. For instance, the large hydrocarbon molecules in heavy gas oil are catalytically "cracked" into the smaller hydrocarbon molecules that make up gasoline. Two-thirds of the oil taken from Earth fuels transportation of one sort or another. Most of the rest heats buildings, generates electricity, or becomes petrochemical products: fertilizers, medicines, cosmetics, plastics, fabrics, and synthetic rubber. Petroleum also provides lubrication for machinery, and asphalt for waterproofing and building roads.

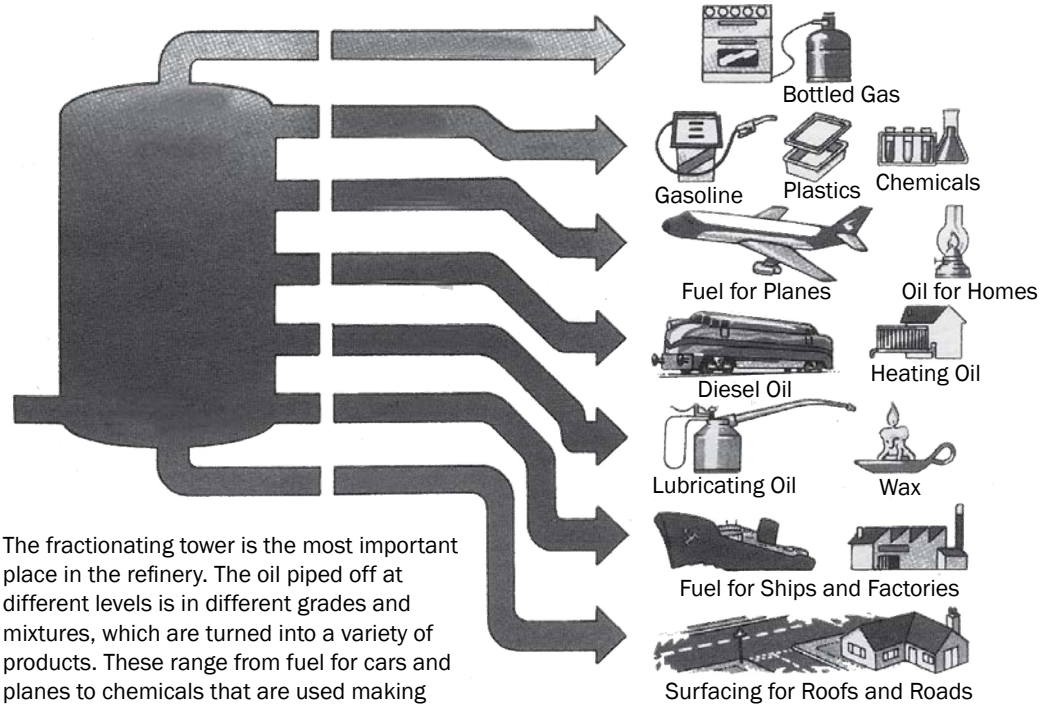
The gasoline goes from the refinery via pipeline to a distribution terminal or bulk plant, where it may be stored briefly before being sent by truck to the gas station where you buy it. Around 2.6 billion gallons of gasoline were delivered to Wisconsin in 2016.

Procedure

Orientation

Discuss the importance of gasoline in our lives. Have students describe various ways people depend on this fuel. Challenge students to think of ten examples within one minute (e.g., an emergency medical service vehicle transporting an injured child to the hospital, a truck delivering food to a grocery store, running errands around town, commuting to school).

A Fractioning Tower



The fractionating tower is the most important place in the refinery. The oil piped off at different levels is in different grades and mixtures, which are turned into a variety of products. These range from fuel for cars and planes to chemicals that are used making fertilizers and medicines.

Ask students what is involved in getting gasoline for cars. Students may mention that people go to gas stations and fill their cars' tanks. Press students to explain what's really involved in getting gasoline. See if they can explain where gasoline comes from. Show students the ***Oil Production Career Cards***. Explain that each card contains a career title and description of a job pertaining to getting oil from its source to the gasoline pump. Tell students their challenge will be to put the cards in the proper sequence.

Steps

1. Divide the class into small groups and give each group a shuffled set of ***Oil Production Career Cards***. Group members can be responsible for certain duties such as the Reader, Discussion Leader, Recorder, and Reporter.

2. Ask each group to arrange the cards in what they think is the best order. Warn students that there are duplicates of some cards, because similar jobs are involved at different steps of the production process.

3. You may want to time the activity or provide some incentives to instill a sense of competition. Incentives include prizes for the group who gets done first, the group with the most logical sequence, the group that worked together most cooperatively, etc. If students need more help, provide them with the main titles for oil production (Exploring for Oil, Drilling a Well, etc.). The most important objective is for students to place the careers under the correct step title; the order of careers under each step title is not as crucial.

   NOTE: There are a variety of ways students can accomplish this task. You may want to share information from the Background with them first, or see how well they can arrange the cards based on previous knowledge and reasoning skills, and then provide background information later.

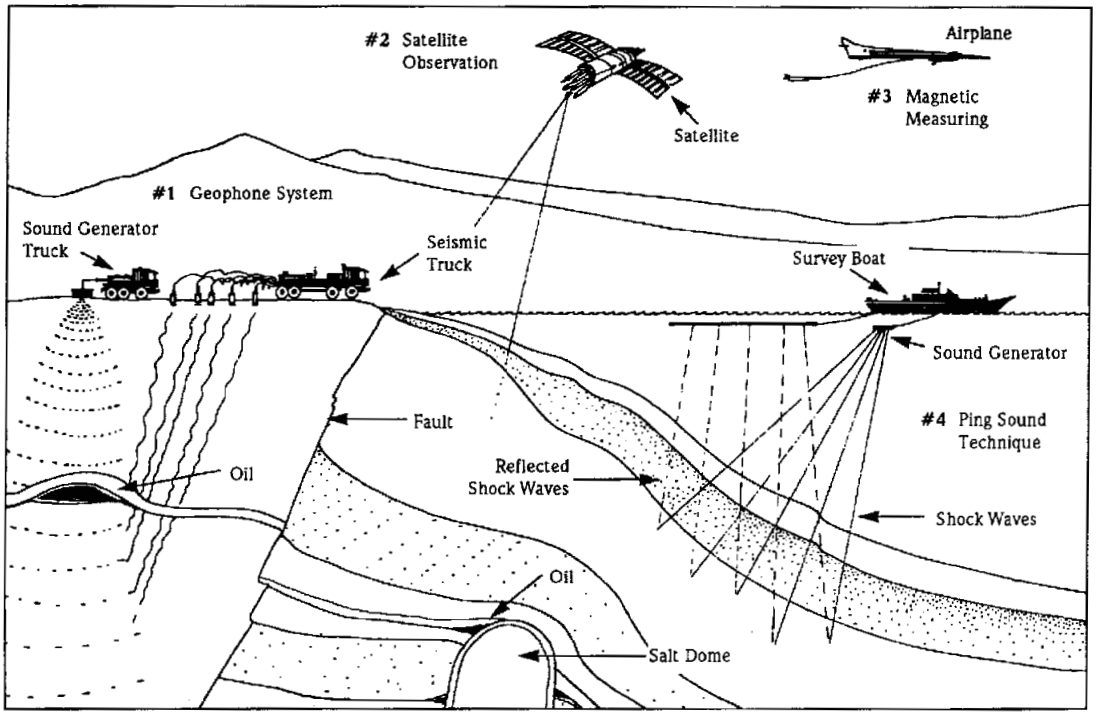
   One technique involves:

   - listing the steps of oil production first (based on background reading or educated guesses); then
   - reading the career descriptions on the cards; and finally
   - matching the cards to listed steps, adding or refining steps as needed.

4. Ask each group to explain the career pathways and relationships they have devised. Have groups compare their arrangements.

5. Present students with the order of steps given on the original ***Oil Production Career Cards*** sheet. Ask

Exploring for Oil



students to evaluate their own sequencing, making sure the career titles are under the correct step title. Explain to students that these tasks are not necessarily sequential. Activities of some workers occur simultaneously or may overlap.

Closure

Have students summarize the steps and careers involved in getting gasoline. Ask them to think of end uses of other energy resources (such as electricity, heating, food production) and contemplate the many careers involved in making this energy available.

Students can use creative strategies to present information about careers related to oil development or another energy resource (see **Assessment**). What other careers, not directly related to energy development, are influenced by oil production? (Answers may include environmental protection, automobile industry, tourism, trucking, and other transportation-related occupations.) What industries depend on other oil products (like plastics, heating, road construction)? The list is massive!

Assessment

Formative

- Did students sequence cards correctly?
- Did students provide logical explanations for their arrangements?

Summative

Require students to draw a diagram or create a wall-sized mural of the steps it takes to get oil from the well to a car. Include drawings of people of different professions working in appropriate settings with appropriate equipment.

Extensions

Use this activity to facilitate career exploration. Have students work in teams to investigate the various careers identified in the activity. They should research the training and skills required for each job, starting wages and industry average wages, other perks/interesting features/dangers of the job. Have students participate in mock job interviews where an employer asks the job applicant about his or her skills and experiences. The role-players can also discuss job benefits and risks.

Invite technical workers in oil production or some other field of energy production to speak to the class about their jobs. Encourage students to ask questions about what training and education prepared these workers for their positions. Have students research vocational programs in the area that offer courses in these fields.

Adapt the game to include cards that identify environmental problems associated with each stage of oil extraction and refining (or some other energy resource development process). Have students research careers that address these problems (for an example, see below).

Have students research how other energy resources are developed. They can make cards for each of these career titles and challenge other groups to correctly sequence the cards. Another component of this extension is for students to compare the complexity of developing the various energy resources (such as renewable vs. nonrenewable).

Related KEEP Activities

Orient students to this activity by having them analyze how we use energy in transportation. Have students use

Oil Production and the Environment

Process	Associated Environmental Problems	Careers
Oil extraction	Ground water contamination	Biochemist, Ground water specialists
Oil transportation	Habitat destruction, oil spills	Wildlife manager
Oil refining	Air pollution emissions	Environmental engineer

the activity “Driving Reasons” to relate driving practices to fuel production. You can extend this activity by having students identify how many other petroleum products they use; see K-5 Energy Sparks for Theme II: “Fossil Fuel Products.” The activity “Advertising Energy” can be used by students to analyze how gasoline and other petroleum products are presented in commercials. Students can find out how their grandparents managed without petroleum products by using surveys in the activity “Energy Use Then and Now.” Have students participate in the activity “Careers in Energy” to find out more about energy-related occupations. Environmental problems associated with energy resource development are introduced in “Digging for Coal” and in Investigation Ideas: “Energy and the Environment” in the Energy Sparks section. The activity “Energy Futures” discusses differing views regarding the availability of oil resources and has students project possible future scenarios.

Credits

Activity adapted from The Watercourse and Western Regional Environmental Education Council (WREEC). “Wet-Work Shuffle” pp. 360-364 in Project Wet. Bozeman, Mont.: The Watercourse and Western Regional Environmental Education Council (WREEC), 1995. Used with permission. All rights reserved.

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The Wisconsin K-12 Energy Education Program is supported through funding from

Wisconsin K-12 Energy Education Program (KEEP)
College of Natural Resources
University of Wisconsin-Stevens Point

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Oil Production Career Cards

NOTE: This is a limited list of careers involved in oil extraction and refinery. The occupational titles and descriptions represent those within the United States (no offshore drilling, no foreign imports). The arrangement of the careers is based on a series of titled steps. The sequence of the careers within each step may vary somewhat, because the responsibilities of some careers coincide or overlap. In addition, different oil companies may use different occupational titles. It is assumed that crude oil is transported by pipeline to and from the refinery; therefore, there are similar career titles for both these steps.

Step 1: Exploring for Oil (4 Careers)

Geologist: A scientist who locates oil deposits by studying the overall structure and composition of Earth's crust.

Geophysicist: A scientist who maps geological formations that may contain oil through the use of seismic waves, magnet survey data, and magnetism of rocks to determine if potential reservoir could be profitable.

Surveyor: A person who makes measurements to determine the boundaries of public or private land that is being explored for oil.

Petrologist: A type of geologist who looks for rock formations that are likely to contain oil by analyzing rock samples brought to the surface by drilling.

Step 2: Drilling a Well and Extracting Oil (10 Careers)

Landman: A person who obtains the right to drill for oil from private property owners.

Petroleum Engineer: An engineer who designs drilling methods that extract the maximum amount of oil from an underground deposit over a long period of time.

Drilling Supervisor or **"Tool Pusher"**: A person who oversees the construction and overall operation of the drill rig.

Petroleum Technician: A person who assists geologists, petroleum engineers, and drilling supervisors in collecting, analyzing, and presenting seismic and drilling data.

Rig Builder: A person who helps put the drill rig together.

Oil Production Career Cards

Step 2 Continued: Drilling a Well and Extracting Oil (10 Careers)

Rotary Driller: A person who selects the drill bits needed to drill through a particular layer of rock and who oversees the daily progress of the drilling operation. He or she also supervises the rotary helpers.

Derrick Operator: A person who works on the top platform of a drill rig, where he or she assembles and disassembles the drilling pipe, and who also mixes the drilling fluid or "mud" used to lubricate the drill bit.

Rotary Helper or "Roughneck": A person who helps assemble and disassemble the drilling pipe and who also runs the engine that drills the well.

Roustabout: A person who performs manual labor at a drilling rig, including maintaining equipment, loading and unloading supplies, and cleaning drill rig floors and drilling pipe.

Oil Conservation Division Engineers: A person who works to protect surface/underground water and other natural resources. They approve the drilling plans, witness tests, and check blow out prevention plans.

Step 3: Transporting Crude Oil from the Well to the Refinery by Pipeline (11 Careers)

Environmental Advisor: A person who ensures all state and federal regulations are followed in the transporting of the crude oil from well to refinery.

Pipeline Bender: A person who bends the pipeline to match the topography of the land.

Pipeline Tester: A person who uses ultra-sonic equipment to test the welds on the pipeline.

Lowering Crew: A person who is part of a crew to get the pipeline lowered into the ground.

District Supervisor: A manager who oversees the crews that maintain the pipeline.

Pipeline Repairer: A person who repairs pipelines and pipeline equipment.

Oil Production Career Cards

Step 3 Continued: Transporting Crude Oil from the Well to the Refinery by Pipeline (11 Careers)

Operational Control Worker: A person who tracks the flow of oil through the pipeline and who regulates the pumps that move the oil.

Welder: A person who joins the pipe sections together.

Spacer or String Crew: A person who makes sure the pipe sections are properly aligned.

Machine Operator (Ditching, Backhoe, Bulldozer): A person who cuts the trench through the earth for the pipeline, or helps to bulldoze and backfill the hole after the pipeline has been lowered into the ground.

Civil Engineer: An engineer who designs the pipeline for petroleum transport and who oversees construction.

Step 4: Refining Crude Oil into Gasoline (7 Careers)

Control Room (Control Panel) Operator: A person who operates controls that regulate the temperature, pressure, rate of flow, and the storage tank levels within a petroleum refinery.

Treater: A person who controls equipment that removes impurities from gasoline.

Chemist: A scientist who develops new refinery products, including new gasoline blends. The chemist also designs tests to make sure that the gasoline being refined meets required standards for quality.

Chemical Engineer: An engineer who designs refineries and refinery equipment and who develops new and improved refinery processes.

Laboratory Technician: A person who tests samples of gasoline to make sure they meet required standards for quality.

Refinery Manager: A person who manages various operations in the refinery including overseeing delivery of crude oil, keeping track of the flow of refinery products, planning production schedules, and coordinating workers' activities.

Oil Production Career Cards

Step 4 Continued: Refining Crude Oil into Gasoline (7 Careers)

Maintenance Worker: A person who inspects and repairs refinery equipment, keeps the refinery clean, and guards against potential fire hazards.

Operational Control Worker: A person who tracks the flow of gasoline through the pipeline and who regulates the pumps that move the gasoline.

District Supervisor: A manager who oversees the crews that maintain the pipeline.

Step 5: Transporting Gasoline from Refinery by Pipeline to a Terminal and Then by Truck to the Service Station (8 Careers)

Civil Engineer: An engineer who designs the pipeline for petroleum transport and who oversees construction.

Pipeline Repairer: A person who repairs pipelines and pipeline equipment.

Ditching-Machine Operator: A person who cuts the trench through the earth for the pipeline.

Tank Truck Driver: A person who delivers gasoline from the terminal to the service station.

Spacer or String Crew: A person who makes sure the pipe sections are properly aligned.

Step 6: Dispensing Gasoline at Service Stations (1 Career)

Dealer: A person who manages the operation of the service station, including purchasing gasoline from the refinery. The dealer may also own the service station.

Welder: A person who joins the pipe sections together.

Facts about Oil

Introduction

The most versatile fossil fuel, oil has made possible many of the necessities and conveniences of modern society. Without oil, much of today's transportation system would grind to a halt and many products we rely on would not exist. This dependence, which sometimes leads to international conflict, along with oil's finite supply and environmental problems, has become an increasing concern in a world that thirsts for the miracle liquid many call "black gold."

Crude oil is a yellow-to-black, sticky substance found inside sponge-like sedimentary rocks that remains a liquid when brought to the surface. It is made of hydrocarbons, organic compounds consisting entirely of hydrogen and carbon atoms. Petroleum products are produced from the processing of crude oil and other liquids and include liquefied petroleum gases, aviation gasoline, motor gasoline, kerosene, fuel oil, petrochemical feedstocks, lubricants, waxes, asphalt, road oil. Petroleum is a broad category that includes both crude oil and petroleum products. The terms oil and petroleum are sometimes used interchangeably.

The crude oil we extract today was formed millions of years ago when dead organisms such as plankton, bacteria, and plant matter were deposited on the sea floor. Sediments accumulated above the organic material over millions of years, the organic material decomposed and the heat and pressure broke it into hydrocarbons/oil. Because they were formed in similar ways, crude oil is often found together with natural gas.

One gallon of crude oil contains 138,095 Btu of energy. One barrel of oil contains 42 gallons. One quad equals 172.4 million barrels.

Reserves, Production, and Consumption

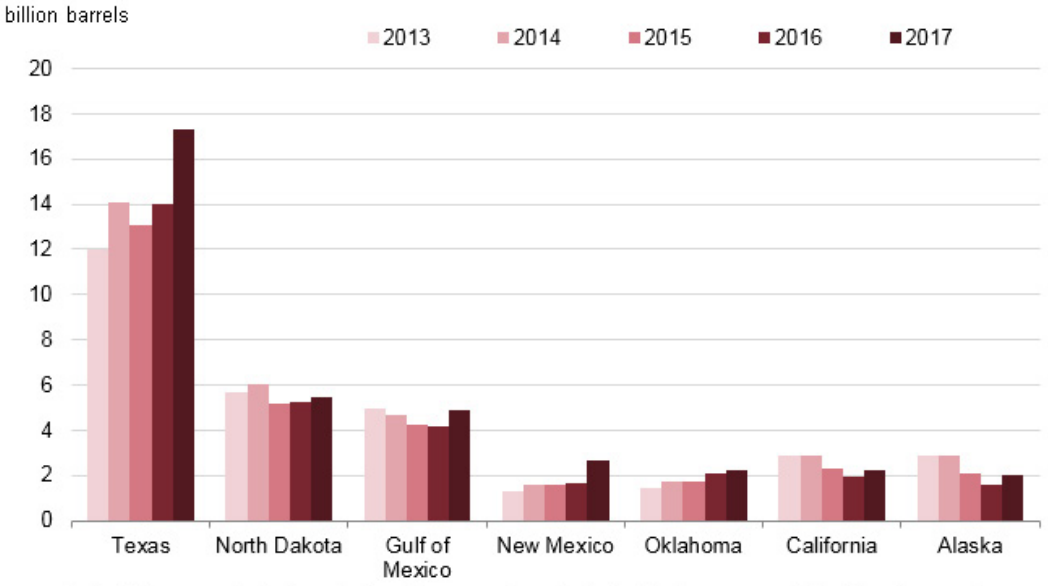
Known crude oil reserves in the United States in 2015 equaled 35.2 billion barrels. Outside the U.S. Venezuela has the largest amount of known oil reserves at 302 billion barrels, followed by Saudi Arabia, Iran, Iraq, and Kuwait.

Total domestic crude oil production averaged about 8,900,000 barrels per day in 2016. The top crude oil producing states/regions in 2016 were Texas, North Dakota, California, Alaska, Oklahoma, and the Gulf of Mexico. (see chart Proved reserves of the top five U.S. oil reserves states, 2011-2015) The world produced 80,557,000 barrels per day in 2016 with about 44 percent of world production from OPEC countries. OPEC is the Organization of the Petroleum Exporting Countries, which was formed to secure fair and stable prices for petroleum producers and regular supply to consumers. The top oil producers in the world are Russia, Saudi Arabia, the United States, Iran, Iraq, China, and Canada.

In 2016, the United States consumed a total of 7.21 billion barrels of petroleum products, an average of about 19.69 million barrels per day. The United States imported approximately 10 million barrels per day in 2016 coming from 70 different countries including Canada, Saudi Arabia, Venezuela, Mexico, and Colombia. Over 3.5 billion gallons of petroleum products were used in Wisconsin in 2012, all of which were imported into the state. Total world consumption of petroleum and other fuel liquids increased 1.5% between 2015 and 2016. A similar trend is projected to continue.

Facts about Oil

Figure 2. Proved reserves of the top seven U.S. oil reserves states, 2013–17



Notes: Oil reserves include crude oil and lease condensate. Gulf of Mexico represents the federally owned offshore portion of the Gulf of Mexico. Although not a state, it is an important U.S. oil and natural gas production area.
Source: U.S. Energy Information Administration, Form EIA-23L, *Annual Report of Domestic Oil and Gas Reserves*, 2013–17

Extracting Crude Oil

Geologists and geophysicists search for oil by conducting underground seismic, gravitational, and magnetic tests. Wells are drilled when tests indicate a strong likelihood of oil. Crude oil under pressure flows to the surface on its own. This type of extraction is referred to as primary oil extraction. Secondary extraction techniques typically make use of water or gas injected to displace oil and drive it to a production wellbore. Tertiary, or enhanced oil recovery (EOR) techniques are more invasive but have the potential to ultimately produce 30 to 60 percent of the reservoir's original oil in place.

Processing and Transporting

Crude oil is transported by pipelines and oceangoing tankers to refineries. About 45 percent of a typical barrel of crude oil is refined into gasoline. An additional 29 percent is refined to diesel fuel. The remaining oil is used to make plastics and other products (see image Products made from a barrel of crude oil, 2016). After refining, gasoline and other types of fuel oil are transported by barges, rail, and pipelines to local storage tanks, and then delivered to homes, businesses, and gas stations by tanker trucks (see map Wisconsin Petroleum Pipelines).

Electricity Production

In some parts of the United States, fuel oil is used in power plants to produce electricity, although it accounts for less than 1 percent of total electricity generation. These power plants are usually smaller than those that use coal, natural gas or nuclear energy. Many oil-fired power plants are only used when the demand for electricity is high, because it costs less to produce electricity using other sources.

Facts about Oil

Other Uses

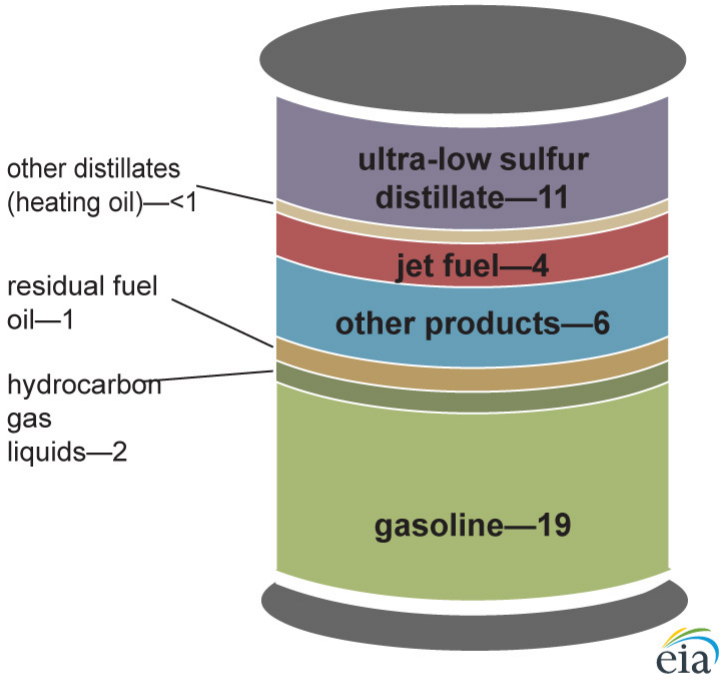
Fuels made from oil run power machinery, cars, trucks, and airplanes. Petroleum fuels also provide heat for homes. Over 3,000 different kinds of products can be made from oil. These products include asphalt, lubricants, ink, cosmetics, and waxes. Crude oil is also used to make plastic products such as bags, bottles, inline skate wheels, and parts for computers, stereos, and automobiles.

Effects

Because of its many uses, some view oil as the lifeblood of modern civilization. Numerous occupations, ranging from geologists and drill rig workers to gas station managers and attendants have been created by the oil industry. However, oil drilling can damage sensitive wilderness areas. Uncontrolled releases of oil from drilling (called blow-outs) have been a problem in the past, although successful steps have been taken to prevent them. Spills by oil tankers have polluted oceans and inland waterways, harming aquatic life.

Petroleum products made from a barrel of crude oil, 2018

gallons



Note: A 42-gallon (U.S.) barrel of crude oil yields about 45 gallons of petroleum products because of refinery processing gain. The sum of the product amounts in the image may not equal 45 because of independent rounding.

Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, April 2019, preliminary data.

Although cleaner burning than coal, petroleum fuels release carbon dioxide, unburned hydrocarbons, sulfur oxides, and carbon monoxide into the atmosphere when burned. Emissions of these substances from automobiles contribute to smog and ground level ozone formation in urban areas, which can lead to respiratory illness. However, automobiles made today are more fuel-efficient and emit fewer pollutants than older models, reducing or slowing increases of harmful emissions.

A significant portion of human-generated greenhouse gases come from oil combustion. Scientists assert that the buildup of human-caused greenhouse gases have contributed to widespread climate change.

Increasing oil imports by the United States have led to concerns over dependence on unreliable oil supplies. For instance, turmoil in the Middle East in 1973, 1979, and 1990 led to worldwide oil supply disruptions and sudden price increases. In response, the United States began to store crude oil in old salt mines and other underground formations. The strategic Petroleum Reserve has a design capacity of 714 million barrels of oil, enough to last the nation up to three months.

Facts about Oil

Outlook

Crude oil is a finite resource and is predicted to run out within the next 25 years; however, there is the potential that global reserves could increase with technological advances in methods of production/ extraction. U.S. production, which had been declining from 1970 to 2012, is a more immediate concern. Sources of oil, such as shale oil extraction, that were previously more expensive have now become more economically feasible. Although oil exploration within the United States continues and new oil fields are still being discovered, much of the United States has been thoroughly explored. However, the increase in types of extraction may aid in future production. Imports into the U.S. are likely to be reduced as crude oil production is expected to rise through 2020. Continued improvements in automobile efficiency and increasing the use of other efficient means of transportation should help to extend oil supplies and reduce imports in the future.

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The Wisconsin K-12 Energy Education Program is supported through funding from

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