Natural Gas

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What Is Natural Gas?

Natural gas is generally considered a **nonrenewable fossil fuel**. (*There are some renewable sources of methane, the main ingredient in natural gas, also discussed in this fact sheet.*) Natural gas is considered a fossil fuel because natural gas was formed from the remains of tiny sea animals and plants that died 300 to 400 million years ago.

When these tiny sea animals and plants died, they sank to the bottom of the oceans where they were buried by layers of sediment that turned into rock. Over the years, the layers of **sedimentary** rock became thousands of feet thick, subjecting the energy-rich plant and animal remains to enormous pressure. Most scientists believe that the pressure, combined with the heat of the Earth, changed this organic mixture into petroleum and natural gas. Eventually, concentrations of natural gas became trapped in the rock layers like a sponge traps water.

Raw natural gas is a mixture of different gases. The main ingredient is **methane**, a natural compound that is formed whenever plant and animal matter decays. By itself, methane is odorless, colorless, and tasteless. As a safety measure, natural gas companies add a chemical odorant called **mercaptan** (it smells like rotten eggs) so escaping gas can be detected. Natural gas should not be confused with gasoline, which is made from petroleum.

History of Natural Gas

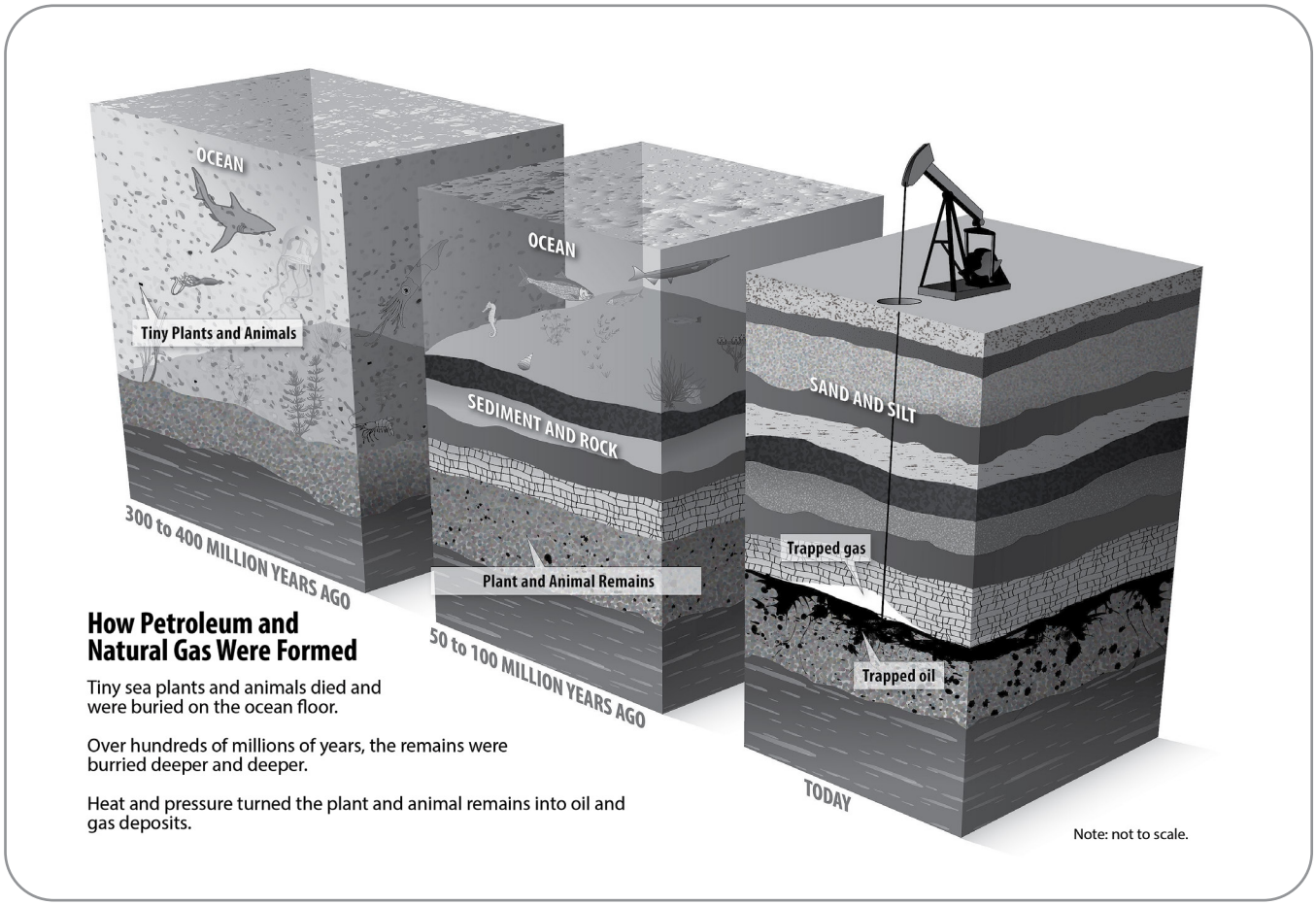
The ancient peoples of Greece, Persia, and India discovered natural gas many centuries ago. The people were mystified by the burning springs created when natural gas seeping from cracks in the ground was ignited by lightning. They sometimes built temples around these eternal flames so they could worship the mysterious fire.

About 2,500 years ago, the Chinese recognized that natural gas could be put to work. The Chinese piped the gas from shallow wells and burned it under large pans to evaporate seawater for the salt.

Natural gas was first used in America in 1816 to illuminate the streets of Baltimore with gas lamps. Lamplighters walked the streets at dusk to light the lamps.

Soon after, in 1821, William Hart dug the first successful American natural gas well in Fredonia, NY. His well was 27 feet deep, quite shallow compared to today's wells. The Fredonia Gas Light Company opened its doors in 1858 as the nation's first natural gas company.

By 1900, natural gas had been discovered in 17 states. In the past 40 years, the use of natural gas has grown. Today, natural gas accounts for over 29 percent of the energy we use.



Natural Gas

Natural Gas at a Glance, 2017

Classification:
- nonrenewable

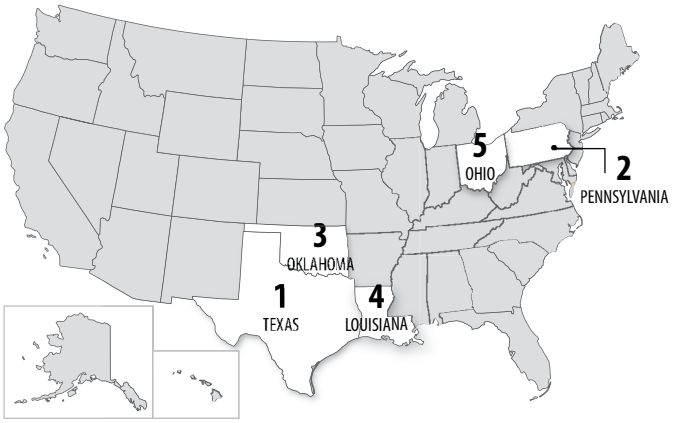
Major Uses:
- heating, industry, electricity

U.S. Energy Consumption:
- 28.034 Q
- 28.66%

U.S. Energy Production:
- 28.274 Q
- 32.03%

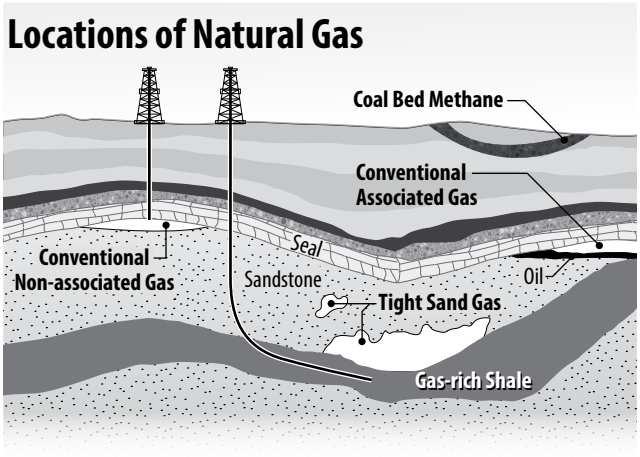
Data: Energy Information Administration

Top Natural Gas Producing States, 2017

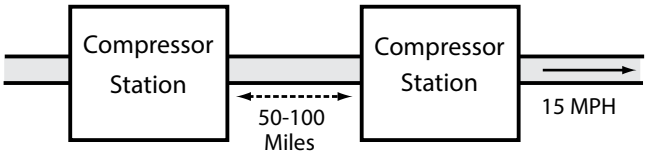


Data: Energy Information Administration

Locations of Natural Gas



Natural Gas Distribution System



Producing Natural Gas

Natural gas can be difficult to find since it is usually trapped in **porous** rocks deep underground. Geologists use many methods to find natural gas deposits. They may look at surface rocks to find clues about underground formations. They may set off small explosions or drop heavy weights on the Earth's surface and record the sound waves as they bounce back from the sedimentary rock layers underground. They also may measure the gravitational pull of rock masses deep within the Earth.

If test results are promising, the scientists may recommend drilling to find the natural gas deposits. Natural gas wells average more than 8,600 feet deep and can cost hundreds of dollars per foot to drill, so it's important to choose sites carefully.

In the past few years, around 60 percent of the **exploratory wells** produced gas. The others came up dry. The odds are better for **developmental wells**—wells drilled on known gas fields. Over 90 percent of the developmental wells drilled recently yield gas. Natural gas can be found in pockets by itself or in petroleum deposits.

After natural gas comes out of the ground, it goes to a processing plant where it is cleaned of impurities and separated into its various components. Approximately 90 percent of natural gas is composed of methane, but it also contains other gases such as propane and butane.

Natural gas may also come from several other sources. One source is coalbed methane, natural gas found in seams of coal. Until recently, coalbed methane was just considered a safety hazard to miners, but now it is a valuable source of natural gas. Just under three percent of the total natural gas produced in the last few years came from coalbeds.

Another source of natural gas is the methane produced in landfills. Landfill gas is considered a renewable source of methane since it comes from decaying garbage. This **biogas** recovered from landfills is usually burned on the landfill site to generate electricity for the facility itself.

Today, natural gas is produced in 35 states, but the top five states—Texas, Pennsylvania, Oklahoma, Louisiana, and Ohio—produce 57 percent of the total. Natural gas is also produced offshore. A little less than five percent of U.S. natural gas comes from offshore wells. Altogether, the U.S. produces about one-fifth of the world's natural gas each year.

Transporting and Storing Natural Gas

How does natural gas get to you? Usually by pipeline. Over 2.4 million miles of underground **pipelines** link natural gas wells to cleaning plants to major cities across the United States. Natural gas is sometimes transported thousands of miles by pipeline to its final destination.

A machine called a **compressor** increases the pressure of the gas, forcing the gas to move along the pipelines. Compressor stations, which are spaced about 50 to 100 miles apart, move the gas along the pipelines at about 15 miles per hour.

Some gas moved along this subterranean highway is temporarily stored in huge underground reservoirs. The underground reservoirs are typically filled in the summer so there will be enough natural gas during the winter heating season.

Eventually, the gas reaches the city gate of a local gas utility. The pressure is reduced and an odorant is added so leaking gas can be detected. Local gas companies use smaller pipes to carry gas the last few miles to homes and businesses. A gas meter measures the volume of gas a consumer uses.

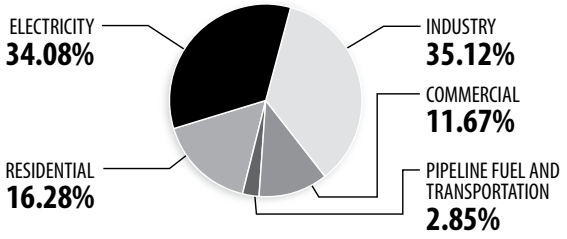
Natural Gas Use

Just about everyone in the United States uses natural gas. Natural gas ranks second in energy consumption, after petroleum. Over one-quarter of the energy we use in the United States comes from natural gas.

Industry uses a little more than one-third of the natural gas consumed in the U.S., mainly as a heat source to manufacture goods. Industry also uses natural gas as an ingredient in fertilizer, photographic film, ink, glue, paint, plastics, laundry detergent, and insect repellents. Synthetic rubber and man-made fibers like nylon also could not be made without the chemicals derived from natural gas.

Homes and businesses—the residential/commercial sector—consume a little more than one quarter of the natural gas in the country. A little less than half of homes use natural gas for heating. Many homes also use gas water heaters, stoves, and clothes dryers. Natural gas is used so often in homes because it is clean burning. Commercial use of natural gas is mostly for indoor space heating of stores, office buildings, schools, churches, and hospitals.

U.S. Natural Gas Consumption by Sector, 2017



Data: Energy Information Administration

Measuring Natural Gas

Gasoline is sold in gallons, coal in pounds, and wood in cords. Natural gas is sold in cubic feet. We can measure the heat contained in all these energy sources by one common unit of measure. The heat stored in a gallon of gasoline, a pound of coal, or a cubic foot of natural gas can all be measured in **British thermal units** or Btu.

One Btu is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit. One candy bar (an energy source for the human body) has about 1,000 Btu. One cubic foot of natural gas has about 1,036 Btu. Natural gas is usually sold to pipeline companies in standard measurements of thousands of cubic feet (Mcf). One thousand cubic feet of natural gas would fit into a box that is 10 feet deep, 10 feet long, and 10 feet wide. Most residential customers are billed by the number of therms of natural gas they use each month. A therm is a measure of the thermal energy in the gas and is equal to about 98 cubic feet.

Just over 34 percent of natural gas consumed is used to make electricity. For many years, coal was the top fuel used to generate electricity in the U.S. However, in 2016, natural gas became the largest electricity producer, and remains as such. Natural gas power plants are cleaner than coal plants and can be brought on-line very quickly. Natural gas plants produce electricity more efficiently than new coal plants and produce it with fewer **emissions**. Many coal plants in the U.S. have, in fact, been converted to natural gas plants to meet the higher **EPA** air quality standards. Today, natural gas generates 32.24 percent of the electricity in the U.S.

Compressed natural gas is often used as a transportation fuel. Natural gas can be used in any vehicle that has been modified with a special carburetor and fuel tank. Natural gas is cleaner burning than gasoline, costs less, and has a higher octane (power boosting) rating. Today, over 150,000 vehicles run on natural gas in the United States.

Natural Gas Reserves

People in the energy industry use two special terms when they talk about how much natural gas there is—resources and reserves. Natural gas resources include all the deposits of gas that are still in the ground waiting to be tapped. Natural gas **reserves** are only those gas deposits that geologists know, or strongly believe, can be recovered given today's prices and drilling technology.

The United States has large reserves of natural gas. Most reserves are in the Gulf of Mexico and in the following states: Texas, Pennsylvania, Oklahoma, Louisiana, West Virginia, Colorado, Ohio, Wyoming, and New Mexico. If we continue to use natural gas at the same rate as we use it today, the United States has about an eighty year supply.

The U.S. natural gas proved reserves increased by almost 20 percent in 2017 to its highest level ever, 438 trillion cubic feet (Tcf). Starting in the late 1990s, proved reserves increased steadily almost every year due to improvements in shale gas exploration and production technologies.

Natural Gas Prices

Since 1985, natural gas prices have been set by the market. The Federal Government sets the price of transportation for gas that crosses state lines. State public utility commissions will continue to regulate natural gas utility companies—just as they regulate electric utilities. These commissions regulate how much utilities may charge and monitor the utilities' policies.

How much does it cost to heat your home with natural gas? Compared to other energy sources, natural gas is an economical choice, though the price varies regionally. It is about two times cheaper than fuel or heating oil and nearly four times cheaper than electricity, both of which are common fuels used to heat U.S. homes.

Natural Gas and the Environment

All the fossil fuels—coal, petroleum, propane, and natural gas—release pollutants into the atmosphere when burned. The good news is that natural gas is the most environmentally friendly fossil fuel.

Burning natural gas produces less sulfur, carbon, and nitrogen than burning other fossil fuels. Natural gas also emits little ash particulate into the air when it is burned.

Like all fossil fuels, however, burning natural gas produces carbon dioxide, a greenhouse gas. The majority of scientists believe that increasing levels of carbon dioxide in the atmosphere, caused in large part by fossil fuel use, could have long-term effects on the global climate.

Natural Gas

Future of Natural Gas

▪ Shale Gas

Shale gas is natural gas that is trapped in shale formations. Shale is a common form of sedimentary rock. It is formed by the compaction of silt and clay-size mineral particles. Shale formations are found all over the world. The Energy Information Administration had projected that 53 percent of the U.S. natural gas would come from shale gas by 2040. However, in 2017, shale gas accounted for 56 percent of U.S. natural gas production, and those numbers will likely continue to rise.

SHALE GAS PRODUCTION

Horizontal Drilling: A vertical well is drilled to the formation that has been identified as a natural gas reservoir. Then the drill bit can be turned up to a 90 degree angle so that the well parallels the natural gas reservoir. This allows the maximum amount of natural gas to be recovered.

Hydraulic Fracturing: Hydraulic fracturing, or "fracking," uses water, silica (sand), and chemical compounds piped several thousand feet below the Earth's surface, creating cracks or fissures in shale formations. This allows natural gas to be released and flow into the well. Hydraulic fracturing can be used along with horizontal drilling. Once the shale area is reached, the water, chemicals, and sand are pumped in to unlock the hydrocarbons in the shale.

BENEFITS AND CHALLENGES

There are benefits to natural gas development. When burned, it is cleaner than coal or oil, and releases fewer emissions. Advancements in drilling and fracturing techniques have made the extraction of shale gas possible to meet increasing demand for natural gas.

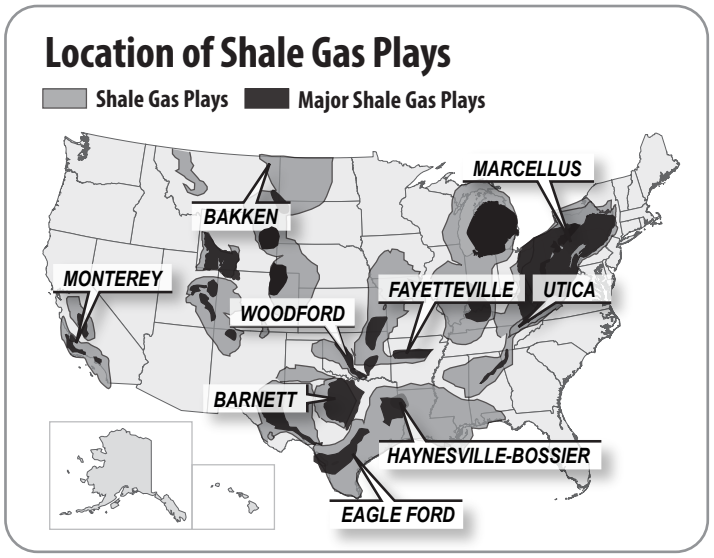
Development of natural gas from shale plays using hydraulic fracturing presents some challenges, including the need for access to water for use in the process, and the need to protect local drinking water and other natural resources. In some areas, development of shale gas brings drilling operations closer to local residential communities too, making land and homeowner cooperation and collaboration a high priority for companies engaged in development of these resources.

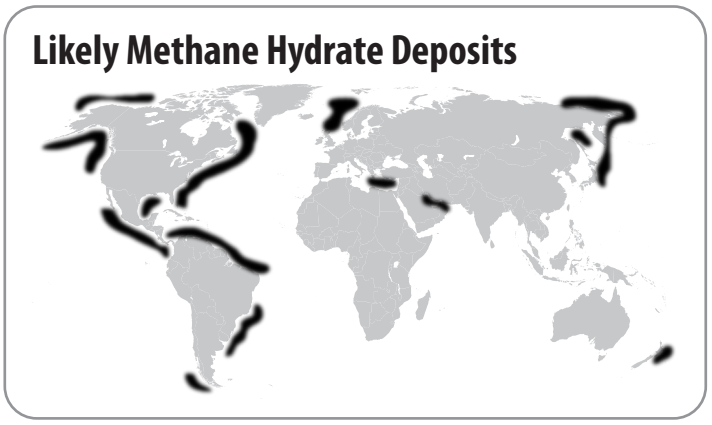
Continued technological innovations promise to make shale gas an important part of the United States' energy future.

▪ Methane Hydrates

Buried in the sediments of the ocean floor is a reserve of methane so vast it could possibly fuel the entire world. In sediments on the ocean floor, tiny bacteria continuously break down the remains of sea animals and plants, producing methane gas. Under the enormous pressure and cold temperatures at the bottom of the sea, this methane gas dissolves and becomes locked in water molecules to form crystals. These crystals cement together the ocean sediments into solid layers—called **methane hydrates**—that can extend down into the sea floor.

Scientists also suspect that huge deposits of free methane gas are trapped beneath the hydrate layer. Researchers estimate there is more carbon trapped in hydrates than in all the fossil fuels; however, they aren't sure how to capture this methane. When a hydrate breaks down, it loses its solidity and turns to mush, causing major landslides and other disturbances to the ocean floor, as well as an increase in methane escaping into the atmosphere.





▪ Biogases

Depending on how the gas is obtained and used, methane from biogases can be classified as a natural gas. Biogases are fuel sources derived from plant and animal waste (see *Biomass*, page 10).

Today, we can drill shallow wells into landfills to recover the methane gas. Landfills are already required to collect methane gas as a safety measure. Typically, landfills collect the gas and burn it to get rid of it; but the gas can be put to work. In 2017, landfill gas generated 11.5 billion kilowatt-hours of electricity.

There are other ways to convert biomass into natural gas. One method converts aquatic plants, such as sea kelp, into methane gas. In the future, huge kelp farms could also produce renewable gas energy.

▪ Liquefied Natural Gas

Another successful development has been the conversion of natural gas into a liquid. As a liquid, natural gas is called LNG, or **liquefied natural gas**. LNG is made by cooling natural gas to a temperature of -260°F. At that temperature, natural gas becomes a liquid and its volume is reduced 600 times. Liquefied natural gas is easier to store than the gaseous form since it takes up much less space. LNG is also easier to transport. People can put LNG in special tanks and transport it on trucks or ships. Today, more than 110 LNG facilities are operating in the United States.

Petroleum

What Is Petroleum?

Petroleum, often known as **oil**, is a **fossil fuel**. It is called a fossil fuel because it was formed from the remains of tiny sea plants and animals that died hundreds of millions of years ago, before dinosaurs lived. When the plants and animals died, they sank to the bottom of the oceans. They were buried by thousands of feet of sediment and sand that turned into rock.

Over time, this organic mixture was subjected to enormous pressure and heat as the layers increased. The mixture changed chemically, breaking down into compounds made of hydrogen and carbon atoms—**hydrocarbons**. Finally, an oil-saturated rock—much like a wet household sponge—was formed.

All organic material buried underground does not turn into oil. Certain geological conditions must exist within the rock formations for the transformations to occur. First, there must be a trap of non-porous rock that prevents the material from seeping out, and a seal (such as salt or clay) to keep the material from rising to the surface. Even under these conditions, only about two percent of the organic material is transformed into oil.

A typical petroleum reservoir is mostly sandstone or limestone in which oil is trapped. The oil in it may be as thin as gasoline or as thick as tar. It may be almost clear or black. Petroleum is called a **nonrenewable** energy source because it takes hundreds of millions of years to form. We cannot make more oil in a short time.

Petroleum at a Glance, 2017

Classification:
- nonrenewable

Major Uses:
- transportation, industry

U.S. Energy Consumption:
- 36.174 Q
- 36.98%

U.S. Energy Production:
- 19.535 Q
- 22.13%

Data: Energy Information Administration

History of Oil

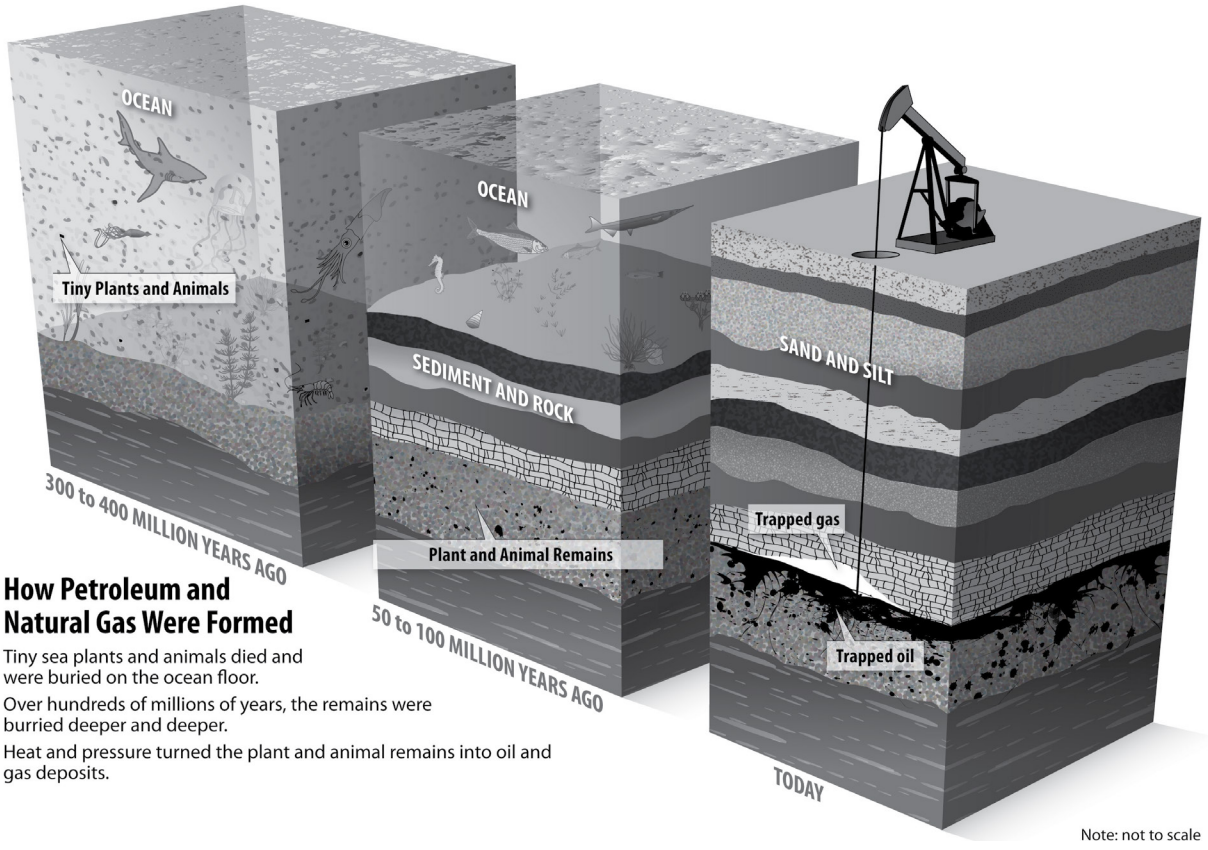
People have used naturally available **crude oil** for thousands of years. The ancient Chinese and Egyptians, for example, burned oil to produce light.

Before the 1850s, Americans often used whale oil for light. When whale oil became scarce, people began looking for other oil sources. In some places, oil seeped naturally to the surface of ponds and streams. People skimmed this oil and made it into **kerosene**. Kerosene was commonly used to light America's homes before the arrival of the electric light bulb.

As demand for kerosene grew, a group of businessmen hired Edwin Drake to drill for oil in Titusville, PA. After much hard work and slow progress, he discovered oil in 1859. Drake's well was 69.5 feet deep, very shallow compared to today's wells.

Drake refined the oil from his well into kerosene for lighting. **Gasoline** and other products made during refining were simply thrown away because people had no use for them.

In 1892, the horseless carriage, or automobile, solved this problem since it required gasoline. By 1920, there were nine million motor vehicles in this country and gas stations were opening everywhere.



How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor.

Over hundreds of millions of years, the remains were burried deeper and deeper.

Heat and pressure turned the plant and animal remains into oil and gas deposits.

Note: not to scale

Petroleum

Producing Oil

Although research has improved the odds since Edwin Drake's days, petroleum exploration today is still a risky business. Geologists study underground rock formations to find areas that might yield oil. Even with advanced methods, only between 60 and 75 percent of exploratory wells find oil, depending on the region. Developmental wells fare much better; over 90 percent can find oil.

When the potential for oil production is found on shore, a petroleum company brings in a 50 to 100-foot **drilling rig** and raises a **derrick** that houses the drilling tools. Today's oil wells average over 6,000 feet deep and may sink below 20,000 feet. The average well produces 10-15 barrels of oil, a day, depending how the well is drilled. However, some new wells can yield over 1,000 barrels per day.

To safeguard the environment, oil drilling and oil production are regulated by state and federal governments. Oil companies must get permission to explore for oil on new sites. Experts believe that much of our remaining oil reserves are on land owned by the Federal Government. Oil companies lease the land from the Federal Government, which, in return, receives rental payments for the mineral rights as well as percentage payments from each barrel of oil.

Texas produces more oil than any other state. The other top producing states are North Dakota, Alaska, California, and New Mexico. These five states account for 64 percent of all U.S. crude oil production. In all, 32 states produce petroleum.

From Well to Market

We cannot use crude oil exactly as it comes out of the ground. The process is a little more complicated than that. So, how does thick, black crude oil come out of the ground and eventually get into your car as a thin, amber-colored liquid called gasoline?

Oil's first stop after being pumped from a well is an oil refinery. A **refinery** is a plant where crude oil is processed. Sometimes, refineries are located near oil wells, but usually the crude oil has to be delivered to the refinery by ship, barge, pipeline, truck, or train.

After the crude oil has reached the refinery, huge round tanks store the oil until it is ready to be processed. **Tank farms** are sites with many storage tanks.

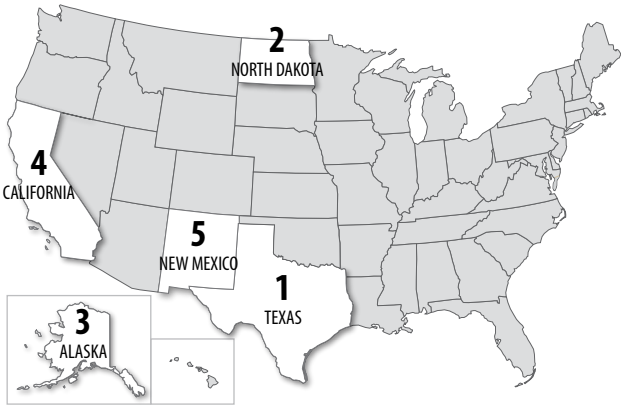
An oil refinery cleans and separates the crude oil into various fuels and by-products. The most important one is gasoline. Some other petroleum products are **diesel fuel**, heating oil, and jet fuel. Chemical processes in refineries can take 42 gallons in a barrel and actually create the equivalent of 45 gallons of products.

Refineries use many different methods to make these products. One method is a heating process called **distillation**. Since oil products have different boiling points, molecule sizes, and densities, the end products can be distilled, or separated. For example, asphalts have a higher boiling point than gasoline, allowing the two to be separated.

Refineries have another job. They remove contaminants from the oil. A refinery removes sulfur from gasoline, for example, to increase its efficiency and to reduce air pollution.

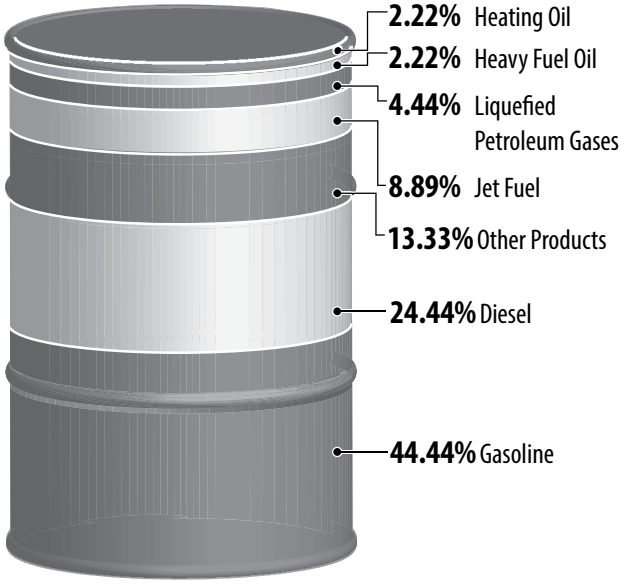
Not all of the crude oil sent to a refinery is turned into product. A small percentage of the energy in the crude oil is used to operate the refinery facility.

Top Petroleum Producing States, 2017



Data: Energy Information Administration

Products Produced From a Barrel of Oil, 2017



Shipping Oil Products

Pipelines are the safest and cheapest way to move large quantities of crude oil or refined petroleum across land. About 190,000 miles of small gathering lines and large trunk lines move crude oil from wells to refineries.

Pump stations, which are spaced 20 to 100 miles apart along the underground pipelines, keep the petroleum products moving at a speed of about five miles per hour. At this rate, it takes two to three weeks to move a shipment of gasoline from Houston, TX to New York City. Petroleum is transported over water via tanker.

Distribution

Companies called **jobbers** handle the wholesale distribution of oil. They sell just about everything that comes out of a barrel of crude oil. Jobbers fill bulk orders for petroleum products from gasoline stations, industries, utility companies, farmers, and other consumers.

The retailer is the next link in the chain. A retailer may be a gasoline station or a home heating oil company. The last link is when you pump gasoline into your car, and the engine converts the gasoline's chemical energy into motion to move your car.

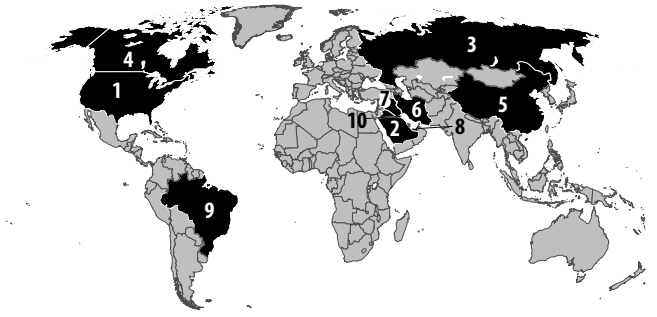
Demand for Oil

Since World War II, petroleum has replaced coal as the leading source of energy consumed in the United States. Petroleum supplies about 37 percent of total U.S. energy demand. Natural gas supplies about 29 percent, and coal supplies about 14 percent of our total energy needs.

America uses about 19.9 million barrels of oil (about 898 million gallons) every day of the year. And experts say we will continue to use oil at these rates, especially for transportation, in the coming years.

Even now, we use about 53 percent more oil than we did in 1973, simply for transportation. This is true even though today's vehicles get almost twice as many miles per gallon as their 1970s counterparts, because there are almost twice as many vehicles on the road today than in 1973 when the first oil crisis hit the U.S. Today, about 71 percent of U.S. oil consumption is used for transportation.

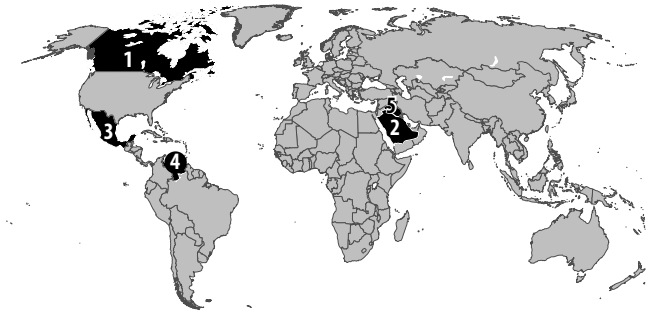
Top Oil Producing Countries, 2017



1. United States
2. Saudi Arabia
3. Russia
4. Canada
5. China
6. Iran
7. Iraq
8. United Arab Emirates
9. Brazil
10. Kuwait

Data: Energy Information Administration

Top Sources of U.S. Imported Oil, 2017



1. Canada, non-OPEC
2. Saudi Arabia, OPEC
3. Mexico, non-OPEC
4. Venezuela, OPEC
5. Iraq, OPEC

Percentage of Imports from the Non-Opec Nations: 67.41%
Percentage of Imports from OPEC Nations: 33.48%

Data: Energy Information Administration

Imported Oil

The United States uses more petroleum than it produces. In 2017, we imported 40 percent of our crude oil supply from other countries.

Many Americans believe this dependence on imported petroleum is problematic and reduces America's energy security and the ability to withstand disruption of supply. We were first alerted to that reality in 1973 when a group of Arab countries stopped supplying oil (called an **oil embargo**) to the United States. These countries belonged to an international trade group called the Organization of Petroleum Exporting Countries, or **OPEC** for short. OPEC member countries often set production levels for petroleum. OPEC member nations include Saudi Arabia, Venezuela, United Arab Emirates, Iran, Iraq, Kuwait, and several others mostly in the Middle East and Africa. As a rule, the less oil they produce, the higher the price of oil on the world market.

The next shock came in 1978–1979 when the Iranian Revolution cut off oil production. Again, world oil prices increased. Another major price increase resulted from the Persian Gulf War in 1990–1991, and again after events like the September 11, 2001 attacks, and Hurricane Katrina in the Gulf of Mexico in 2005.

As many countries in the Middle East and North Africa experience political change, petroleum prices may increase temporarily resulting in higher prices for gasoline and other products. Many people believe that prices are less related to oil supply and more related to how petroleum is traded (bought and sold) as a commodity.

The U.S. continues to work to increase energy security and maintain domestic supplies of petroleum—including the purchase and storage of three months of supply in the Strategic Petroleum Reserve (SPR). Established in 1975, the SPR is only to be tapped during an energy emergency. The SPR was first tapped in 1991, during the first Persian Gulf War, and has since been tapped following events like Hurricanes Rita and Katrina in 2005, and the Libyan civil conflict in 2011.

The United States imports oil from both non-OPEC and OPEC countries. Today, we import more oil from Canada than any other country (39.96 percent) followed by Saudia Arabia (9.41 percent). The United States is a major consumer in the global energy economy and access to petroleum resources continues to be a high priority for providing the energy resources needed for transportation and for making many of our consumer goods and products. As countries like China and India grow, their demand for petroleum and petroleum products increases as well. Global demand for oil continues.

There are steps we can take to help ensure our energy security and reduce the impact of high oil prices. Some experts believe the most important step is to decrease our demand for oil through increased conservation, reducing the oil we use, and increasing the efficiency of our vehicles and transportation.

Some people believe we should increase oil production in the United States, particularly in the Arctic National Wildlife Refuge (ANWR) in northern Alaska and in offshore areas. Others say we should increase our use of other transportation fuels. Many people agree that the United States must increase production from domestic sources, increase efficiency, and continue development of non-petroleum transportation fuels.

Offshore Oil Reserves

There are rich deposits of petroleum and natural gas on the **outer continental shelf (OCS)**, especially off the Pacific coasts of California and Alaska and in the Gulf of Mexico. Thirty basins have been identified that could contain enormous oil and gas reserves. It is estimated that 30 percent of undiscovered U.S. gas and oil reserves are contained in the OCS.

Today, there are thousands of drilling platforms, servicing thousands of wells. OCS production supplies approximately 4.66 percent of the nation's natural gas production and 18.12 percent of its oil production. Most of the active wells are in the central and western Gulf of Mexico, with additional wells off the coast of California.

Although there are no producing wells in other areas, there is believed to be significant oil potential in the Beaufort Sea off Alaska, as well as natural gas potential in the eastern Gulf of Mexico and in certain basins off the Atlantic Coast.

The U.S. Department of the Interior (DOI) grants permission to use offshore lands through lease sales. After companies pay for a lease, they apply for U.S. DOI permits to develop energy resources from the lease. A lease is generally nine square miles. Currently, the entire Pacific Coast, parts of the Gulf of Mexico, the entire Atlantic Coast, and parts of Alaska are restricted from new lease sales, due to a mandate through 2017. Leases and new production still occur in unblocked areas of the Gulf of Mexico and Alaskan Coast. However, the current U.S. government administrators are proposing opening production and lease sales in these areas beginning in 2019.

Offshore Production

Offshore production is costly—many times more expensive than land-based production. To reach oil buried in shallow water, drilling platforms stand on stilt-like legs that are imbedded in the ocean floor. These huge platforms hold all the drilling equipment needed, as well as housing and storage areas for the work crews. Once the well has been drilled, the platforms also hold the production equipment.

Floating platforms are used for drilling in deeper waters. These self-propelled vessels are anchored to the ocean bottom with huge cables. Once the wells have been drilled from these platforms, the production equipment is lowered to the ocean floor and sealed to the well casings to prevent leakage. Wells have been drilled in 10,000 feet of water using these floating rigs.

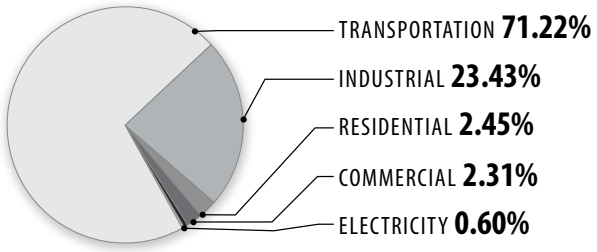
In 2010, the Macondo (Deepwater Horizon) well accident released oil into the Gulf of Mexico for several months. The companies involved in developing Macondo, the Coast Guard, and the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) quickly began work to determine the cause of the accident and to improve production and safety standards as a result.

Oil Prices

Most of the world moves on petroleum—gasoline for cars, jet fuel for planes, and diesel fuel for trucks. Then there are the petroleum products needed to run factories and manufacture goods. That's why the price of oil is so important. In 1998, the average price of a barrel of oil dropped as low as $11 a barrel; in the spring and summer of 2008, the price shot up to over $130 a barrel, the highest price in history. The average price at the end of 2017 was just about $60 a barrel.

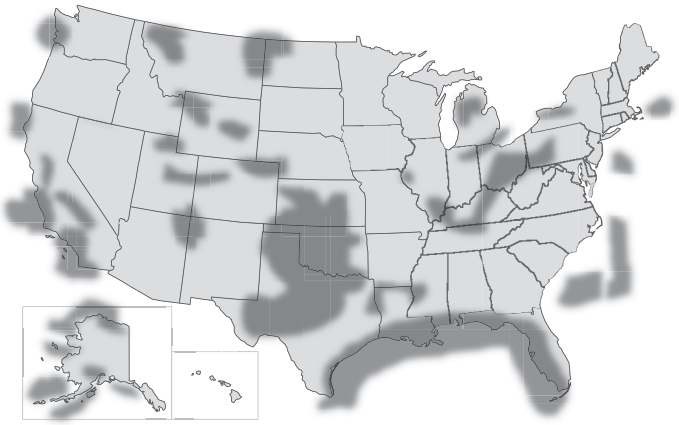
Low oil prices are good for the consumer and the economy, acting as a check on inflation. The oil industry, however, does not prosper during periods of low oil prices. Oil industry workers lose their jobs, many small wells are permanently sealed, and the exploration for new oil sources drops off. Low oil prices have another side effect. People use more petroleum products when crude oil is cheap. They buy bigger cars and drive more miles. Urban air quality suffers.

U.S. Petroleum Consumption by Sector, 2017



Data: Energy Information Administration

U.S. Oil and Gas Basins



Data: Energy Information Administration

Oil and the Environment

In the United States, we use more petroleum than any other energy source. Petroleum products—gasoline, fertilizers, plastics, medicines—have brought untold benefits to Americans and the rest of the world. We depend on these products, and, as consumers, we demand them. Petroleum production, distribution, and consumption can also contribute to air and water pollution.

Drilling for and transporting oil can endanger wildlife and the environment if it spills into rivers or oceans. Leaking underground storage tanks can pollute groundwater and create noxious fumes. Processing oil at the refinery can contribute to air and water pollution. Burning gasoline to fuel our cars contributes to air pollution. Even the careless disposal of waste oil drained from the family car can pollute rivers and lakes.

Many advances have been made in protecting the environment since the passage of the Clean Air Act in 1970. Oil companies have redesigned their refineries to reduce emissions into the air and water. Gasolines have been reformulated to burn cleaner, dramatically cutting the levels of lead, nitrogen oxide, carbon monoxide, and hydrocarbons released into the air.

The production, transportation, distribution, and consumption of petroleum are strictly regulated to minimize the negative effects on the environment. Our increasing dependence on petroleum presents a continuing challenge. The future must balance the growing demand for petroleum products with protection of the global environment.

Propane

What Is Propane?

Propane is a gas found mixed in natural gas and petroleum deposits. To obtain propane, it must be separated from natural gas and crude oil when they are processed for their final uses. Propane is called a **fossil fuel** because it was formed hundreds of millions of years ago from the remains of tiny sea animals and plants. When the plants and animals died, they sank to the bottom of the oceans and were buried by layers of sediment and sand that turned into rock. Over time, the layers became thousands of feet thick.

The layers were subjected to enormous heat and pressure, changing the energy-rich remains into petroleum and natural gas deposits. Eventually, pockets of these fossil fuels became trapped in rocks, similar to the way a wet sponge holds water.

Propane is one member of the family of **hydrocarbon gas liquids** (HGL). These **hydrocarbons** are mixtures of molecules of hydrogen and carbon that can occur as gases, or can be easily pressurized to become liquids. HGLs are found in both natural gas and crude oil because both are mixtures of hydrogen and carbon. Once natural gas and petroleum

Propane at a Glance, 2017

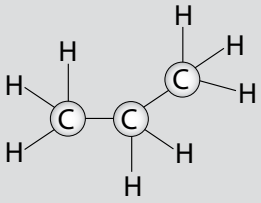
Classification:
- nonrenewable

Major Uses:
- industry, heating, transportation

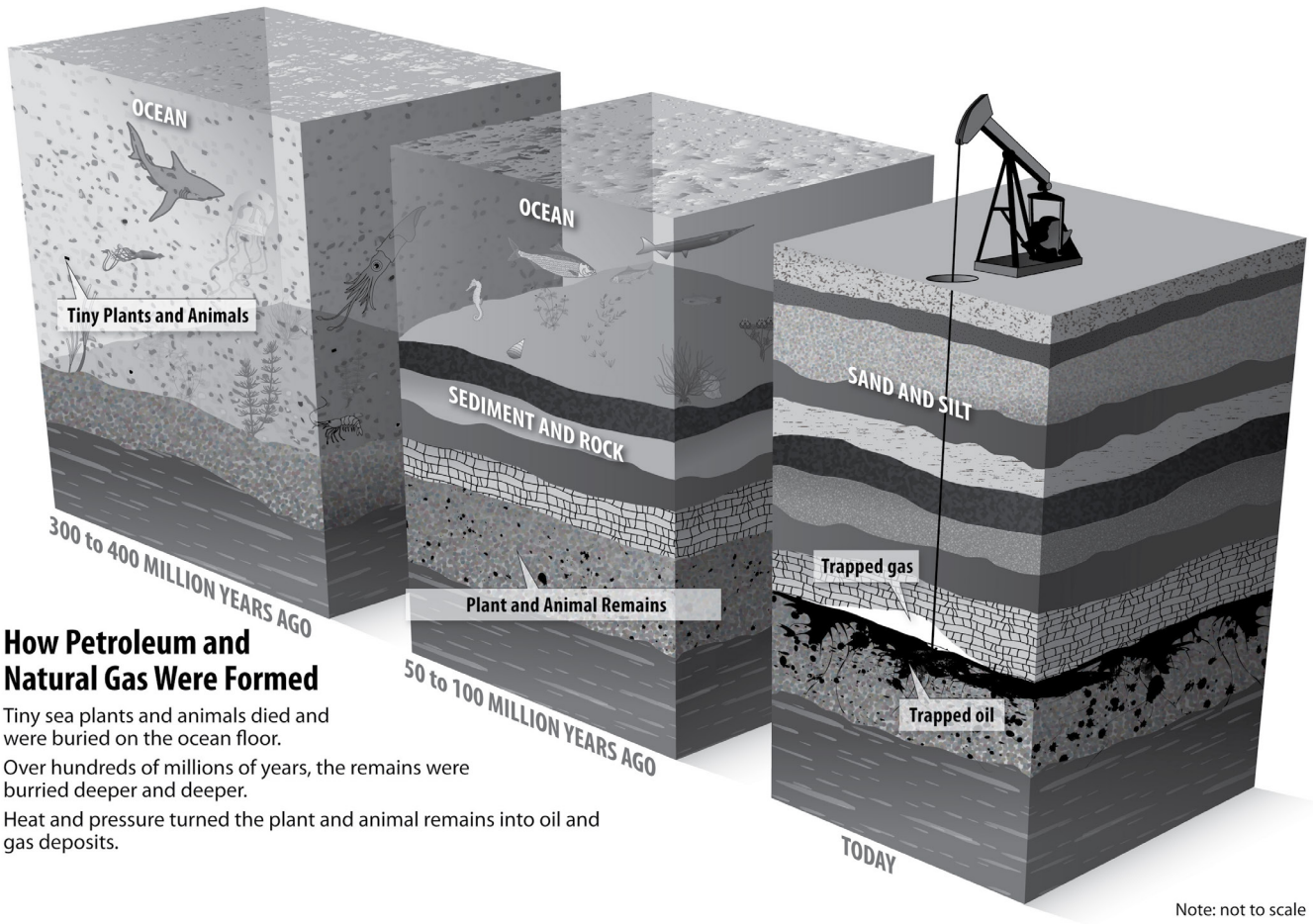
Alternative Names:
- Hydrocarbon Gas Liquid (HGL)
- Liquefied Petroleum Gas (LPG)

Consumption and Production
- produced from refined petroleum and natural gas
- more than 1 million barrels produced per day

PROPANE = C_3H_8



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 hundreds of millions of years, the remains were burried deeper and deeper.

Heat and pressure turned the plant and animal remains into oil and gas deposits.

Note: not to scale

Propane

are processed, the HGLs can be extracted. These materials straddle the line between gas and liquids, and this makes them very versatile for making products and use for energy consumption. Propane is a special type of HGL called **liquefied petroleum gas** (LPG), that is extracted from refining crude oil and natural gas. Propane (C_3H_8) is the most common LPG, but the fuels isobutane and butane are also classified as LPGs. Butane is often used in lighters, while isobutane is used as a fuel and as a propellant for aerosols. HGLs account for a small percentage of U.S. petroleum consumption because of their many uses in creating products, and as fuels for transportation, heating, cooking, and drying. Propane, or LPG, is the most used gas liquid in the U.S.

Just as water can change its physical state and become a liquid or a gas (steam vapor), so can propane. Under normal atmospheric pressure and temperature, propane is a gas. Under moderate pressure and/or lower temperatures, however, propane changes into a liquid. Propane is easily stored as a liquid in pressurized tanks. Think of the small tank you see attached to a gas barbecue grill, for example.

Propane takes up much less space in its liquid form. It is 270 times more compact in its liquid state than it is as a gas. A thousand gallon tank holding gaseous propane would provide a family enough cooking fuel for one week. A thousand gallon tank holding liquid propane would provide enough cooking fuel for more than five years!

When propane vapor (gas) is drawn from a tank, some of the liquid in the tank instantly vaporizes to replace the vapor that was removed. Propane is nicknamed the portable gas because it is easier to store and transport than natural gas, which requires pipelines.

Like natural gas, propane is colorless and odorless. An odorant called **mercaptan** is added to propane (as it is to natural gas) to serve as a warning agent for escaping gas. And, like all fossil fuels, propane is a **nonrenewable** energy source. We can't make more propane in a short period of time.

History of Propane

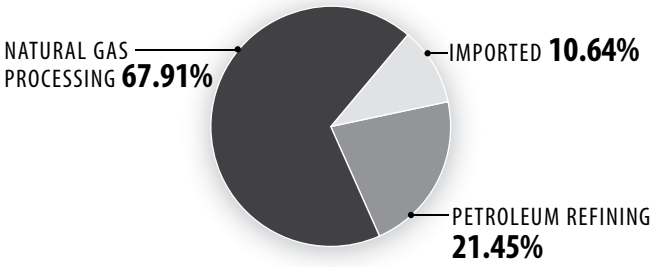
Propane does not have a long history. It wasn't discovered until 1912 when people were trying to find a way to store gasoline. The problem with gasoline was that it evaporated when stored under normal conditions.

Dr. Walter Snelling, directing a series of experiments for the U.S. Bureau of Mines, discovered that several evaporating gases could be changed into liquids and stored at moderate pressure. The most plentiful of those gases was propane. Dr. Snelling developed a way to bottle the liquid gas. One year later, the propane industry began heating American homes. By 1915, propane was being used in torches to cut through metal.

Producing Propane

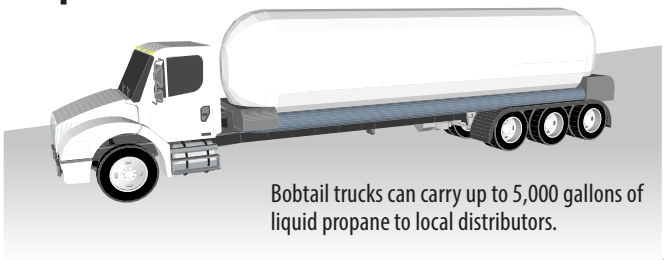
Propane comes from natural gas and petroleum wells. About 68 percent of the propane used in the United States is extracted from raw natural gas. Raw natural gas contains about 90 percent methane, five percent propane, and five percent other gases. The propane is separated from the raw natural gas and the other gases at a natural gas processing facility.

Sources of U.S. Propane, 2015



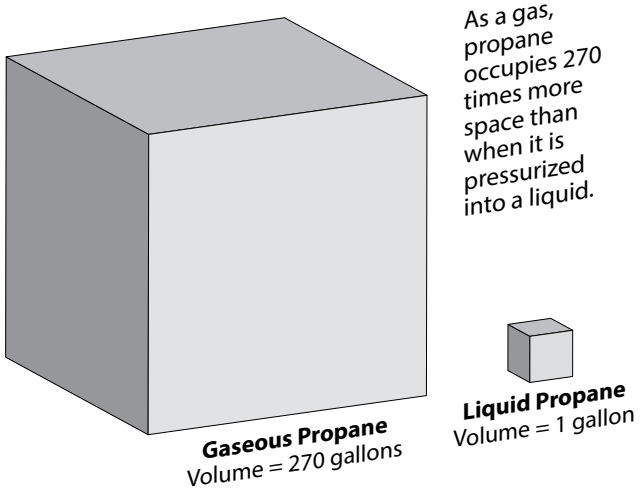
Data: Energy Information Administration

Propane Truck



Bobtail trucks can carry up to 5,000 gallons of liquid propane to local distributors.

Liquefied Propane



About 18 percent of propane is extracted from crude petroleum. Petroleum is separated into its various products at a processing plant called a **refinery**. Almost 14 percent of the propane we use in the U.S. is imported from other countries, mostly from Canada by rail car.

Transporting Propane

How does propane get from natural gas processing plants and oil refineries to the consumer? Usually, propane first moves through underground pipelines to distribution terminals across the nation. There are about 70,000 miles of pipeline in the United States moving propane to bulk storage and distribution terminals.

Distribution terminals, which are operated by propane companies, function like warehouses that store merchandise before shipping it to stores and shops. Sometimes, especially in the summer when less energy is needed for heating, propane is stored in large underground storage caverns.

After storage at distribution terminals, propane is transported by railroad tank cars, transport trucks, barges, and tanker ships to bulk plants. A **bulk plant** is where local propane dealers fill their small tank trucks, called bobtails.

People who use very little propane—backyard barbecuers, for example—must bring their propane cylinders to a dealer to be filled. There are over 100,000 propane dealers, such as hardware stores and gas stations, in the U.S. today.

How Propane Is Used

Propane is a clean-burning, versatile fuel. It is used by nearly everyone in the United States—in homes, on farms, by business, and in industry—mostly for producing heat and operating equipment.

▪ Homes

Homes and businesses are the second largest consumer of propane in the U.S. Propane is used mostly in homes in rural areas that do not have natural gas service, as well as in manufactured (mobile) homes. Millions of homes use propane to meet some of their energy needs. About five million households use propane as their main heating source. Many mobile homes use propane for heating.

Propane is also used in homes for air conditioning, heating water, cooking and refrigerating foods, drying clothes, lighting, and fueling fireplaces.

Homes that use propane as a main energy source usually have a large propane tank outside of the house that stores propane under pressure as a liquid. Propane dealers deliver propane to the residences in trucks, filling the tanks several times a year as needed. The average residential propane tank holds between 500 and 1,000 gallons of liquid fuel.

Millions of backyard cooks use propane-powered gas grills for cooking. Recreational vehicles (RVs) usually have propane-fueled appliances, giving them a portable source of energy for cooking, hot water, and refrigeration.

▪ Farms

Many of America's farms use propane to help meet their energy needs. Farmers use propane to dry crops such as corn, soybeans, grains, tobacco, apples, peanuts, and onions. Propane is also used to ripen fruit, heat water, and refrigerate foods.

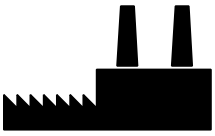
Propane flamethrowers are used to control weeds. Propane is also used to heat barns, chicken houses, stock tanks, nurseries, greenhouses, orchards, and incubators.

Propane is one fuel farmers use to operate a variety of farm equipment, including tractors, weeders, irrigation pumps, stand-by generators, and seedling planters.

RESIDENTIAL TANK

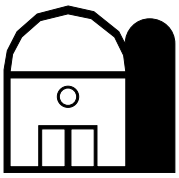
How Propane Is Used

To heat homes



To make products and fuel industry

To fuel backyard grills



To heat barns and operate farm equipment

To fuel fleet vehicles

To fuel machinery that is used indoors

To fuel hot air balloons

To fuel appliances

▪ Business

Some businesses and commercial establishments—such as hotels, schools, hospitals, restaurants, and laundromats—use propane for heating and cooling air, cooking and refrigerating food, heating water, and lighting.

Propane

PROPANE POWERED FORKLIFT

▪ Industry

Industry uses 61 percent of the propane consumed in the U.S. Some industries find propane well suited to their special needs. Metal workers use propane tanks to fuel their cutting torches and other equipment. Industries also use propane for soldering, vulcanizing, and other processes that need a ready heat source.

Portable propane heaters provide a convenient source of heat for construction and road workers in cold weather. Propane also is used to heat asphalt for highway construction and repairs. Propane heaters at construction sites are used to dry concrete, plaster, and fuel pitch. And because propane is a very low-emission fuel, forklift trucks powered by propane can operate safely inside factories and warehouses.

Propane is also a valuable feedstock for the chemical industry. Almost half of the propane used today is as a raw material for making plastic bags, nylon, rubber, pharmaceuticals, and other products.

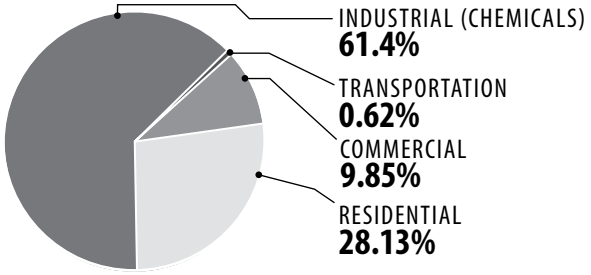
Propane Today

The United States ranks among the world's largest consumers of propane gas. Just under 90 percent of the propane used in this country is produced in the United States from petroleum and natural gas but, since we import 40 percent of the petroleum we use, about 14 percent of the propane we produce here is made from imported fuel.

Propane and the Environment

Propane is a very clean burning fossil fuel, which explains its use in indoor settings. It was approved as an alternative fuel under the Clean Air Act, as well as the National Energy Policy Act of 1992.

U.S. Propane Consumption by Sector, 2017



Propane is used very little for electricity generation. If used for electric power, often it is in off-grid applications.
Data: Energy Information Administration
*Total does not equal 100% due to independent rounding.

Propane as a Transportation Fuel

Did you know that propane has been used as a transportation fuel for more than half a century? Taxicab companies, government agencies, and school districts often use propane, instead of gasoline, to fuel their fleets of vehicles. Today, about one percent of total propane consumption is used for transportation.

There are some interesting characteristics about propane that make it an ideal engine fuel. First, propane is cleaner burning than gasoline. Propane leaves no lead, varnish, or carbon deposits that cause the premature wearing of pistons, rings, valves, and spark plugs. The engine stays clean, free of carbon and sludge. This means less maintenance and an extended engine life.

Also, propane is all fuel. It doesn't require the additives that are usually blended into gasoline. Even without additive boosters, propane's octane rating of 110 is equal to and, in most cases, higher than available gasoline.

A delivery van that runs on propane fuel.

Propane-fueled engines produce less air pollution than gasoline engines. Carbon monoxide emissions from engines using propane are 20 to 90 percent lower than emissions from gasoline-fueled engines. Total hydrocarbon emissions are 40 to 80 percent lower.

So why isn't propane used as a transportation fuel more often? For one reason, propane is not as conveniently available as gasoline. Second, an automobile engine has to be adjusted to use propane fuel, and the cost of converting an engine to use propane is often prohibitive. Third, there is a slight drop in miles traveled per gallon when propane is used to fuel vehicles.