



# Natural Gas

## 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

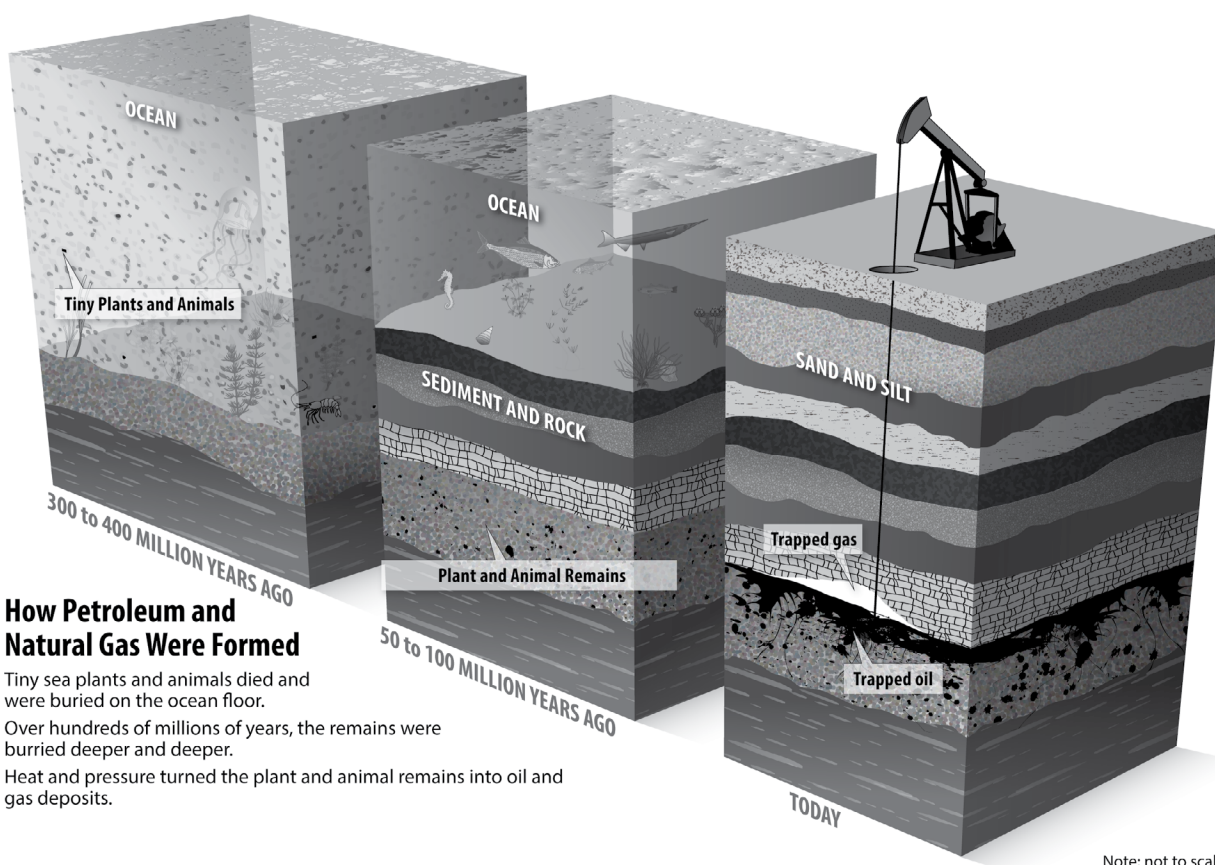
The ancient peoples of Greece, Persia, and India discovered natural gas many centuries ago. The people were mystified by the burning springs created when natural gas seeping from cracks in the ground was ignited by lightning. They sometimes built temples around these eternal flames so they could worship 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 30 percent of the energy we use.



### 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 buried deeper and deeper.

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



# Natural Gas

## Natural Gas at a Glance, 2021

### Classification:

- nonrenewable

### Major Uses:

- heating, industry, electricity

### U.S. Energy Consumption:

- 31.343 Q
- 32.23%

### U.S. Energy Production:

- 35.409 Q
- 36.21%

Data: Energy Information Administration

## 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 recent past, roughly 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.

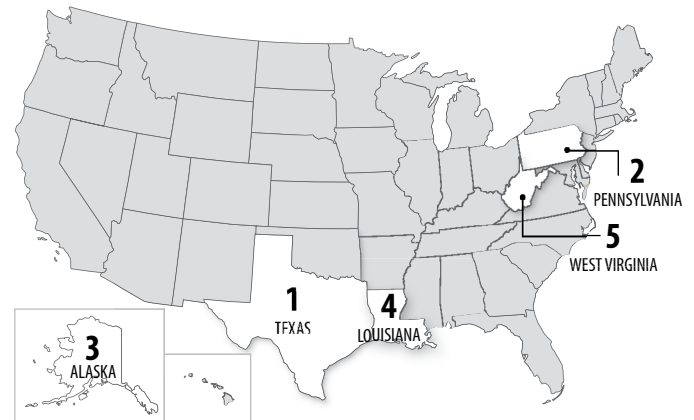
After natural gas comes out of the ground, it goes to a processing plant where it is cleaned of impurities and separated into its various components. Approximately 90 percent of natural gas is composed of methane, but it also contains other gases such as propane and butane.

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.

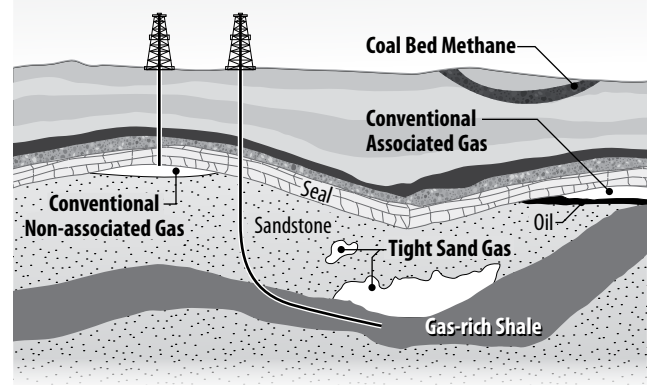
Today, natural gas is produced in 33 states, but the top five states—Texas, Pennsylvania, Alaska, Louisiana, and West Virginia—produce 67 percent of the U.S. total. Natural gas is also produced offshore. A little less than five percent of U.S. natural gas comes from offshore wells. Altogether, the U.S. produces almost one-fourth of the world's natural gas each year.

## Top Natural Gas Producing States, 2021

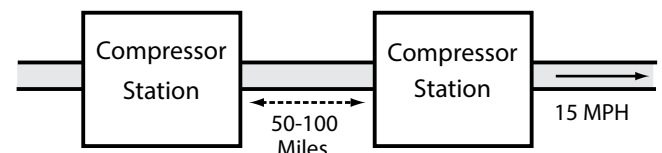


Data: Energy Information Administration

## Locations of Natural Gas



## Natural Gas Distribution System



## 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.

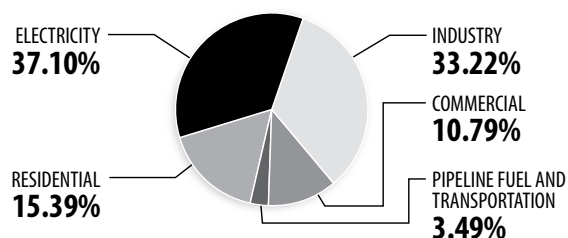
## Natural Gas Use

Just about everyone in the United States uses natural gas. Natural gas ranks second in energy consumption, after petroleum, with 32.23 percent of the energy we use in the United States coming from natural gas.

Industry uses about 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. Approximately half of homes use natural gas for heating and cooking. Many homes also use gas water heaters 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, 2021



Data: Energy Information Administration

\*Total may not equal 100% due to independent rounding.

## 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 1,037 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 96 cubic feet.

About 37 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 so. Natural gas power plants are cleaner than coal plants and can be brought online 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 38.28 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 in the United States run on natural gas.

## 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**, or proven 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 sizeable reserves of natural gas. Most reserves are in the Gulf of Mexico and in the following states: Texas, Pennsylvania, West Virginia, Louisiana, Oklahoma, and Ohio. However, if we continue to use natural gas at the same rate as we use it today, the United States will continue to diminish its reserves.

The U.S. natural gas reserves increased in 2018 to its highest level ever, 500 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. However, in 2019 and 2020 decreases were reported.

## 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 more than 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 burns more cleanly than other fossil fuels. 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. Methane released into the atmosphere before it is burned also contributes to climate change.



# 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 that is formed by the compaction of silt and clay-size mineral particles. Shale formations, also called shale gas plays, 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 2020, shale gas accounted for 63 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.

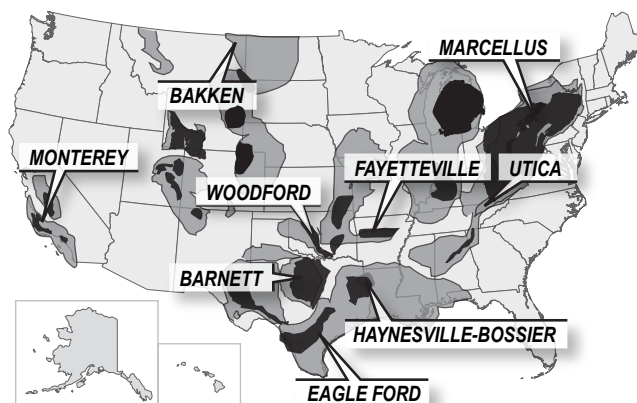
### ■ Methane Hydrates

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.

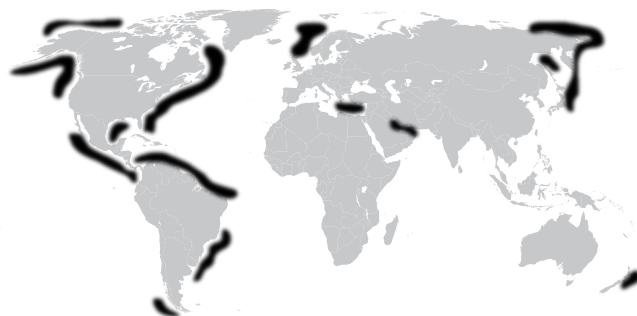
Scientists also suspect that huge deposits of free methane gas are trapped beneath the hydrate layer. Researchers estimate there is more carbon trapped in hydrates than in all the fossil fuels; however, they aren’t sure how to capture this methane. When a hydrate breaks down, it loses its solidity and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

## Location of Shale Gas Plays

■ Shale Gas Plays ■ Major Shale Gas Plays



## Likely Methane Hydrate Deposits



### ■ 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 2020, landfill gas generated 10 billion kilowatt-hours of electricity, less than one percent of all U.S. 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 160 LNG facilities are operating in the United States.