What Is Natural Gas?
Natural gas is considered a nonrenewable fossil fuel. Natural gas is considered a fossil fuel because scientists believe that it was formed from the remains of tiny sea animals and plants that died 300-400 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. 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 wet 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 so escaping gas can be detected. Natural gas should not be confused with gasoline, which is made from petroleum.

What Is LNG?
Liquefied natural gas (LNG) is natural gas that has been cooled until it becomes a liquid. LNG is made by cooling natural gas to -260 degrees Fahrenheit (or -162.2 degrees Celsius). At this temperature, natural gas changes state into a liquid, and its volume is reduced 600 times. LNG, like natural gas, is odorless, colorless, noncorrosive, and nontoxic.

Finding Natural Gas
Natural gas can be hard to find since it can be 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 surface and record the sound waves as they bounce back from the sedimentary rock layers underground. They may also measure the gravitational pull of rock masses deep within the Earth.

How Natural Gas Was Formed
Natural gas and oil were formed in the same way. Hundreds of millions of years ago, tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

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

Oil and natural gas are often found together. Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.
If test results are promising, the scientists may recommend drilling to find the natural gas deposits. After identifying a potential site, companies must obtain environmental assessments and permits before they can begin drilling.

Exploring for natural gas deposits is a high-risk, high-cost enterprise. Natural gas wells average 8,300 feet deep and can cost hundreds of dollars per foot to drill. Only about 61 percent of the exploratory wells produce gas. The others come up dry. The odds are better for developmental wells—wells drilled on known gas fields. On average, 91 percent of the developmental wells yield gas. Natural gas can be found in pockets by itself or in petroleum deposits.

**Production**

- **Natural Gas**

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 ethane, propane, and butane. The composition of natural gas varies according to where it came from and how it has been processed.

Natural gas may also come from several other sources. One source is coalbed methane, natural gas found in coalbeds. Until recently, coalbed gas was just considered a safety hazard to miners, but now it is a valuable source of natural gas. The gas from coalbeds accounts for about seven percent of the total gas supply today.

Another source of natural gas is the gas produced in landfills. Landfill gas is considered a renewable source of natural gas since it comes from decaying garbage. The gas recovered from landfills is usually burned at the landfill site to generate electricity for facility operations.

Today, natural gas is produced in 32 states, but the top five states—Texas, Wyoming, Louisiana, Oklahoma, and Colorado—produce 65 percent of the total. Altogether, the U.S. produces about one-fifth of the world’s natural gas each year.

- **LNG**

The process for making LNG starts the same as producing natural gas. The raw feed gas, or natural gas that has come from the well, must be processed to separate out impurities, such as dirt, hydrogen sulfide, and carbon dioxide. Next, the gas is cooled to allow water to condense and be removed. Additional dehydration is sometimes needed to ensure even small amounts of water vapor are not present. Then the gas is separated into its various components such as propane and butane.

Once the natural gas is clean and dry, it is ready for the liquefaction process. Turning natural gas into LNG takes place through heat exchangers that cool the gas. Gas circulating through aluminum tube coils is cooled by a compressed refrigerant. As the refrigerant vaporizes, it cools the gas in the tubes. The refrigerant returns to a compressor while the LNG is pumped to an insulated storage tank.

The United States does not produce and export LNG on a large scale. LNG is produced in large quantities overseas. The top countries that exported LNG in 2010 were Qatar, Indonesia, Malaysia, Australia, and Nigeria.
Transporting and Storing

- **Natural Gas**

How does natural gas get from the well to the consumer? Usually by pipeline. More than 300,000 miles of underground pipelines link natural gas wells to cleaning plants and then to major cities across the U.S. 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. In the U.S. the underground reservoirs are typically filled in the summer so there will be enough natural gas during the winter heating season.

Eventually the gas is transferred from a transmission pipeline to a local gas utility pipeline. This junction is called the citygate. The pressure is reduced and an odorant is added. 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.

- **LNG**

After liquefaction, LNG is stored in insulated tanks. These tanks are specially designed to keep the interior at extremely low temperatures but the exterior the same temperature as the ambient air or ground. The inner layer of the tank is a steel alloy. Then there are layers of insulation, stainless steel, and additional insulation. The outer layer is reinforced concrete with heating ducts laced throughout to prevent the ground from freezing. The walls of an LNG storage tank can be as much as five-and-a-half feet thick.

Some LNG storage tanks have a containment feature to safeguard against leaks. In these tanks, both the inner and outer walls are capable of holding the LNG. However, most LNG storage facilities in the U.S. use another approach. The storage tank is surrounded by a dam or dike made of soil that provides secondary containment.

LNG is transported world-wide using ships with specifically designed hulls. The current world LNG fleet consists of 360 ships. Modern LNG ships follow two basic designs. The membrane design features multiple tanks with linings made of thin nickel-steel alloy. These tanks are integrated into the hull of the ship, which can be more than six feet thick. The spherical design has round storage tanks that sit on supports on the hull.

Once LNG reaches its destination, pumps transfer it to insulated storage tanks. When the LNG is needed the liquid is warmed and quickly becomes a gas; this is called regasification. Two types of systems are typically used for regasification. Ambient temperature systems use heat from surrounding air or sea water. Above-ambient temperature systems burn a fuel to indirectly warm the liquid using a fluid bath. After regasification, the natural gas can join the network of pipelines used to transport it to consumers.

Storage and transportation of LNG make for its biggest advantages and its biggest disadvantages. Once liquefied, LNG takes up 1/600th the amount of space as it did as natural gas. This is like comparing the volume held in a beach ball to that inside a ping pong ball. This is a great advantage for storage and transportation. More can be stored and moved at one time. Also, LNG can be transported over routes or to locations that do not have natural gas pipelines.

However, because the tanks for storage must be designed for the -260° Fahrenheit temperature (-162.2°C) inside and ambient temperature outside, LNG has distinct disadvantages when compared to natural gas for storage and transportation. Storage tanks must keep the LNG very cold and ships and trucks must be specially made for LNG storage.

A future LNG storage option may lie with underground salt caverns. Rather than offloading the LNG from the ship into above ground storage tanks, it would be pressurized, warmed to 40 degrees Fahrenheit, and then injected into underground salt caverns. This method is called the "Bishop Process." This process is still being studied, but if it proves successful, it would decrease the offloading time of LNG tankers and increase the storage capacity potential of LNG. Suitable salt cavern locations have been located in the U.S., with over 1,000 currently being used for storage and delivery of other fossil fuels.
U.S. LNG Terminals and Storage Facilities

Currently the U.S. has 13 terminals for importing LNG—nine on the mainland, one in Puerto Rico, and three offshore. The mainland terminals are located in Georgia, Louisiana, Maryland, Massachusetts, Mississippi, and Texas. For 45 years the U.S. has had one LNG export facility in Kenai, Alaska. LNG produced in Alaska is exported to Japan and other countries. In 2009, the U.S. imported 431 billion cubic feet (Bcf) of LNG. About 44 percent came from Trinidad and Tobago. Another 17 percent came from Egypt.

Besides the mainland and offshore terminals, there are more than 100 facilities located throughout the U.S. that store LNG or supply natural gas to rural areas. Many LNG storage facilities are located in the eastern U.S. and are concentrated around major urban areas.

Natural Gas Use

Just about everyone in the U.S. uses natural gas. Natural gas ranks second in energy consumption, after petroleum, which provides 35 percent of our total energy demand. About 25 percent of the energy we use in the U.S. comes from natural gas. In 2010, the U.S. consumed 24.1 trillion cubic feet (Tcf) of natural gas.

Industry is a large consumers of natural gas, using 33 percent of the supply 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.

Electricity generation consumes about 31 percent of natural gas. It is the second largest producer of electricity after coal. Natural gas is a cleaner energy source to burn than coal and produces fewer emissions. The majority of new electric power plants in the past decade were natural gas fired. Combined cycle units are highly efficient and make up the majority of the new electric capacity. Today, natural gas generates 24 percent of the nation’s electricity.

Residences—people’s homes—and businesses also use about one-third of natural gas. Five out of every ten homes use natural gas for heating. Many homes also use gas water heaters, stoves, clothes dryers, and fire places. Natural gas is used so often in homes because it is clean burning. Like residences, commercial use of natural gas is mostly for indoor space heating of stores, office buildings, schools, churches, and hospitals.

Consumer demand for natural gas typically rises and falls based upon the season. This change in demand can usually be handled by gas utilities and the natural gas pipelines that supply them. However, during extreme winters, demand for natural gas increases sharply, or peaks. Gas utilities need reliable sources of gas that can be quickly delivered to the locations that need it. The U.S. has peak-shaving plants that can quickly bring natural gas into the transmission pipelines so that consumers have it available. Half of these peak-shaving plants can store the natural gas as LNG. At these facilities the LNG is either trucked to the site in storage tanks or natural gas is diverted from the pipeline during non-peak periods, liquefied, and then stored until needed. When a peak hits, the LNG is regasified and fed into the regional distribution pipelines.
On a small scale, natural gas is used as a transportation fuel. Natural gas can be used in any vehicle with an internal combustion engine, although the vehicle must be outfitted with a special carburetor and fuel tank. Natural gas is cleaner burning than gasoline, costs less, and has a higher octane (power boosting) rating. In 2010, more than 115,000 vehicles ran on compressed natural gas in the U.S., while about 3,300 used LNG.

LNG is beginning to be used in rural areas as an alternative to propane. Additionally, LNG can meet some distributed energy needs. Distributed energy is generated and stored near the point of use. While natural gas is a popular choice for distributed energy systems, not all locations are within the pipeline distribution system. LNG can bring fuel to an isolated facility that has its own energy system.

A generator is a device that converts mechanical energy into electrical energy. All electric power plants have a generator. What differs from plant to plant is the fuel source and method used to spin the shaft that will spin the generator to produce an electric current.

Electricity generated from natural gas has steadily increased. Most new natural gas electric power plants are building highly efficient combined-cycle units. These units use both gas combustion turbines and steam turbines.

Gas combustion turbines have three main components: a compressor, a combustion system, and a turbine. The compressor (1) draws air into the machine. Here, the air is pressurized and pushed into the combustion chambers. The combustion system consists of fuel injectors and combustion chambers. A ring of fuel injectors puts a stream of fuel (natural gas) into the combustion chambers (2). There the natural gas and air mix. The mixture is burned to produce a high temperature, high pressure stream of gas that moves to the turbine. In the turbine (3) the high temperature, high pressure gas expands causing blades to rotate. The rotating blades are connected to a shaft that spins the electromagnet in the generator (4), producing electricity (9). After the gas passes by the turbine, it is piped into a boiler (5) to produce steam.

Steam turbines have three major components: a boiler, a turbine, and a condenser. In the boiler (5), a fuel is burned, such as natural gas. The heat turns water into steam (6) where it travels to a turbine. The steam moves the blades of the turbine (7), which is attached to the electromagnetic shaft of the generator (8). The rotating electromagnetic shaft in the generator produces electricity (9). After moving through the turbine, the steam goes through the condenser (10) where a coolant, often water, is used to turn the steam into a liquid so it can return to the boiler.