Consumer Information

- How Does the Natural Gas Delivery System Work?
- What Is Natural Gas?
- Natural Gas 101 - An Introduction to the Natural Gas Industry
- Natural Gas: The Basics
- Dry Two Loads Of Laundry With Natural Gas For Same Cost As One Load With Electricity
- Primer on Natural Gas Prices
- Natural Gas Rates
- Natural Gas Pipelines: Safe, Sound and Underground
- What Causes Natural Gas Pipeline Accidents?
- Assisting Income-Eligible Customers Remains Priority for Natural Gas Utilities
- Homegrown Fuel Helps Energize U.S.
- Sources for Information on Using Energy Wisely
- LIHEAP Resources
- Validation of Direct Natural Gas Use to Reduce CO2 Emissions
- Naturally Green Homes

Additional Resources

How Does the Natural Gas Delivery System Work?

Gas flowing from higher to lower pressure is the fundamental principle of the natural gas delivery system. The amount of pressure in a pipeline is measured in pounds per square inch.

From the well, the natural gas goes into "gathering" lines, which are like branches on a tree, getting larger as they get closer to the central collection point.

Gathering Systems

A gathering system may need one or more field compressors to move the gas to the pipeline or the processing plant. A compressor is a machine driven by an internal combustion engine or turbine that creates pressure to "push" the gas through the lines. Most compressors in the natural gas delivery system use a small amount of natural gas from their own lines as fuel.

Some natural gas gathering systems include a processing facility, which performs such functions as removing impurities like water, carbon dioxide or sulfur that might corrode a pipeline, or inert gases, such as helium, that would reduce the energy value of the gas. Processing plants also can remove small quantities of propane and butane. These gases are used for chemical feedstocks and other applications.

The Transmission System

From the gathering system, the natural gas moves into the transmission system, which is composed of about 272,000 miles of high-strength steel pipe ranging from 20 inches to 42 inches in diameter.

These large transmission lines for natural gas can be compared to the nation's interstate highway system for cars. They move large amounts of natural gas thousands of miles from the producing regions to local distribution companies (LDCs). The pressure of gas in each section of line typically ranges from 200 pounds to 1,500 pounds per square inch, depending on the type of area in which the pipeline is operating. As a safety measure, pipelines are designed and constructed to handle much more pressure than is ever actually reached in the system. For example, pipelines in more populated areas operate at less than one-half of their design pressure level.

Many major interstate pipelines are "looped" -- there are two or more lines running parallel to each other in the same right of way. This provides maximum capacity during periods of peak demand. The pipeline rights of way are usually 100 feet wide and are leased from landowners with restrictions on construction activities to minimize the potential for accidental damage.

Compressor Stations

Compressor stations are located approximately every 50 to 60 miles along each pipeline to boost the pressure that is lost through the friction of the natural gas moving through the steel pipe. Many compressor stations are completely automated, so the equipment can be started or stopped from a pipeline's central control room. The control center also can remotely operate shut-off valves along the transmission system. The operators of the system keep detailed operating data on each compressor station, and continuously adjust the mix of engines that are running to maximize efficiency and safety.

Natural gas moves through the transmission system at up to 30 miles per hour, so it takes several days for gas from Texas to arrive at a utility receipt point in the Northeast. Along the way, there are many interconnections with other pipelines and other utility systems, which offers system operators a great deal of flexibility in moving gas.

Linepack

A 50-mile section of 42-inch transmission line operating at about 1,000 pounds of pressure contains about 200 million cubic feet of gas -- enough to power a kitchen range for more than 2,000 years. The amount of gas in the pipe is called the "linepack."

By raising and lowering the pressure on any pipeline segment, a pipeline company can use the segment to store gas during periods when there is less demand at the end of the pipeline. Using linepack in this way allows pipeline operators to handle hourly fluctuations in demand very efficiently.

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Natural gas pipelines and utilities use very sophisticated computer models of customer demand for natural gas, which relate daily and hourly consumption trends with seasonal and environmental factors. That's why customers can depend on the reliability of natural gas -- when it's needed, it's there.

Gate Stations

When the natural gas in a transmission pipeline reaches a local gas utility, it normally passes through a "gate station." Utilities frequently have gate stations receiving gas at many different locations and from several different pipelines. Gate stations serve three purposes. First, they reduce the pressure in the line from transmission levels (200 to 1,500 pounds) to distribution levels, which range from ¼ pound to 200 pounds. Then an odorant, the distinctive sour scent associated with natural gas, is added, so that consumers can smell even small quantities of gas. Finally, the gate station measures the flow rate of the gas to determine the amount being received by the utility.

The Distribution System

From the gate station, natural gas moves into distribution lines or "mains" that range from 2 inches to more than 24 inches in diameter. Within each distribution system, there are sections that operate at different pressures, with regulators controlling the pressure. Some regulators are remotely controlled by the utility to change pressures in parts of the system to optimize efficiency. Generally speaking, the closer natural gas gets to a customer, the smaller the pipe diameter is and the lower the pressure is.

The gas utility's central control center continuously monitors flow rates and pressures at various points in its system. The operators must ensure that the gas reaches each customer with sufficient flow rate and pressure to fuel equipment and appliances. They also ensure that the pressures stay below the maximum pressure for each segment of the system. Distribution lines typically operate at less than one-fifth of their design pressure.

As gas flows through the system, regulators control the flow from higher to lower pressures. If a regulator senses that the pressure has dropped below a set point it will open accordingly to allow more gas to flow. Conversely, when pressure rises above a set point,

the regulator will close to adjust. As an added safety feature, relief valves are installed on pipelines to vent gas harmlessly, if a line becomes overpressured and the regulators malfunction.

Sophisticated computer programs are used to evaluate the delivery capacity of the network and to ensure that all customers receive adequate supplies of gas at or above the minimum pressure level required by their gas appliances.

Distribution mains are interconnected in multiple grid patterns with strategically located shut-off valves, so the utility can perform maintenance of its lines without ever shutting off a customer.

Moving Natural Gas Into the Home

Natural gas runs from the main into a home or business in what's called a service line. Today, this line is likely to be a small-diameter plastic line an inch or less in diameter, with gas flowing at a pressure range of over 60 pounds to as low as ¼ pound. When the gas passes through a customer's gas meter, it becomes the property of the customer. Once inside the home, gas travels to equipment and appliances through piping installed by the home-builder and owned by the customer, who is responsible for its upkeep.

Most gas meters are connected to an inner or outer wall of a home or business. In some instances, however, meters are located next to the point where the service line meets the main line. In this case, the piping from the meter to the structure is the customer's property, not the gas company's. These are called "customer-owned" lines and their maintenance is the responsibility of the customer.

When the gas reaches a customer's meter, it passes through another regulator to reduce its pressure to under ¼ pound, if this is necessary. (Some services lines carry gas that is already at very low pressure.) This is the normal pressure for natural gas within a household piping system, and is less than the pressure created by a child blowing bubbles through a straw in a glass of milk. When a gas furnace or stove is turned on, the gas pressure is slightly higher than the air pressure, so the gas flows out of the burner and ignites in its familiar clean blue flame.