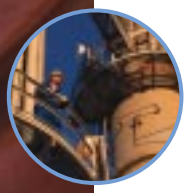


Natural Gas Fundamentals

from Resource to Market

DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA •

Natural Gas and Its Uses

Abundant supplies of energy, including natural gas, are necessary for a healthy U.S. economy and the quality of life that Americans have come to enjoy. As the cleanest fossil fuel, natural gas can further national environmental goals.

Our Nation relies on clean-burning natural gas

Natural gas is a vital contributor to a diverse, well-balanced U.S. energy portfolio. Today, it is the second largest source of energy in the United States next to oil, accounting for 24 percent of all energy consumed.

Natural gas has a critical role in the U.S. economy.

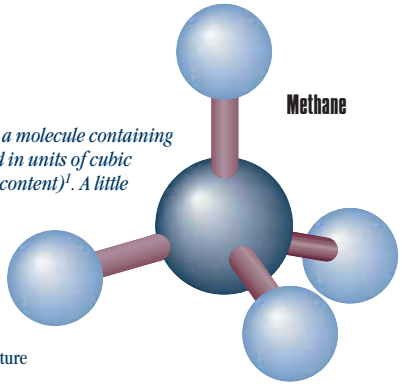
- Natural gas is a dominant fuel for a wide range of industries, including pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic, and food processing.
- Fertilizers, chemicals, fabrics, pharmaceuticals, and plastics are among the products for which natural gas is a feedstock. For many products, viable feedstock alternatives do not exist.
- Over half of America's families and businesses use natural gas. Seventy percent of new single-family homes built in 2001 have natural gas heating. And, thanks to efficiency gains, today's average home uses 22 percent less natural gas than 20 years ago.
- A growing proportion of the Nation's electricity is natural gas-fired. In the last several years, 95 percent of the new power generation capacity built in the United States was gas-fired.
- Over 100,000 natural gas vehicles already operate in the United States, and further growth is expected. [2]

[2] Source: American Gas Association, Natural Gas Supply Association, and others.

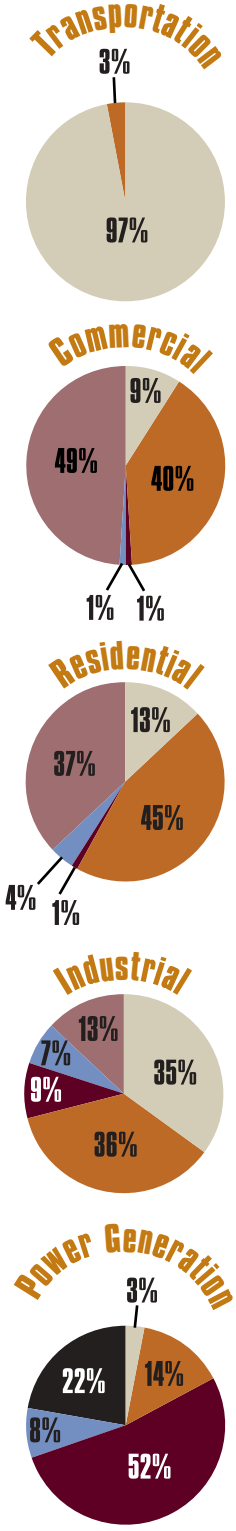
A critical component of America's energy mix

- *Natural gas produces less carbon dioxide and nitrogen oxides than other fossil fuels, and almost no sulfur dioxide and particulates.*
- *With a well-established delivery system, natural gas energy is reliable, convenient, and efficient. Natural gas is easy to transport and does not require onsite storage.*
- *Controllability and flexibility make natural gas an ideal energy source for many industrial applications.*

*Natural gas is generally 90% to 95% methane (CH_4), a molecule containing one carbon and four hydrogen atoms. It is measured in units of cubic feet (volume) or British thermal units or Btus (heat content)[1]. A little over 1,000 Btus are contained in a cubic foot of natural gas. A thousand cubic feet is an **Mcf** of natural gas. A typical American home uses 80 to 90 Mcf in a year. A trillion cubic feet, or **Tcf**, is one billion Mcf.*



[1] A Btu is the amount of heat it takes to raise the temperature of one pound of water one degree Fahrenheit.



Natural gas is essential in the U.S. economy

With more applications for natural gas envisioned in the future — such as greater use of natural gas automobiles and use of natural gas as a feedstock for hydrogen production to power fuel cells — America's requirements for natural gas will continue to evolve.

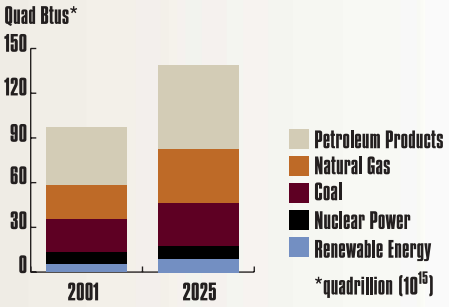
Source: Energy Information Administration. Power Generation data excludes electricity imports (less than 1%).

Demand for natural gas is growing

Natural gas is in strong demand. The United States currently consumes about 63 billion cubic feet (Bcf) every day. Consumption is growing at a faster rate than for any other primary source of energy, and has increased 35 percent in the last decade.

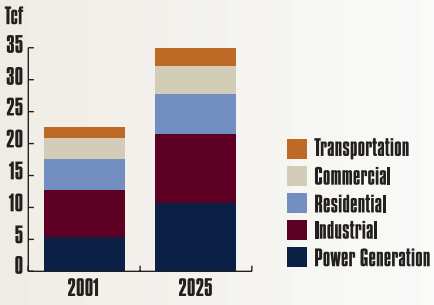
Gas demand is beginning to outpace supply

Over the long term, the Nation must ensure that natural gas supplies keep pace with growing demand, and that adequate infrastructure is in place to bring supplies to regional demand areas. In recent years, in certain times and regions of the country, demand has grown faster than available supplies can be delivered. Such tightening of the demand-supply balance has resulted in dramatic price volatility.



Natural gas consumption outpaces growth of other primary fuels

U.S. natural gas consumption is forecast to increase by an annual rate of 1.8% between 2001 and 2025, in comparison to 1.7% for petroleum and 1.3% for coal.



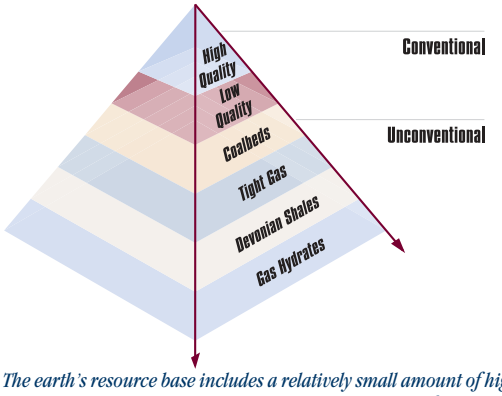
Natural gas consumption is growing in all market sectors

In total, U.S. natural gas consumption is forecast to grow from 23 Tcf annually in 2001 to 35 Tcf by 2025, representing growth of over 50%. The greatest proportional growth is expected in the industrial (45% growth), transportation (56% growth), and power generation sectors (100% growth).

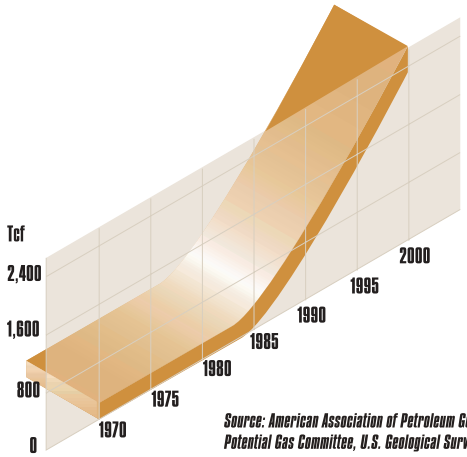
Source: Energy Information Administration

Finding and Producing Natural Gas

U.S. Natural Gas Resource Base



The earth's resource base includes a relatively small amount of high-quality, easily accessible natural gas, but vast amounts of lower quality, less accessible resources. With advances in technology and scientific understanding, lower quality, less accessible resources become more economical to produce, allowing them to make a larger contribution to future supplies.



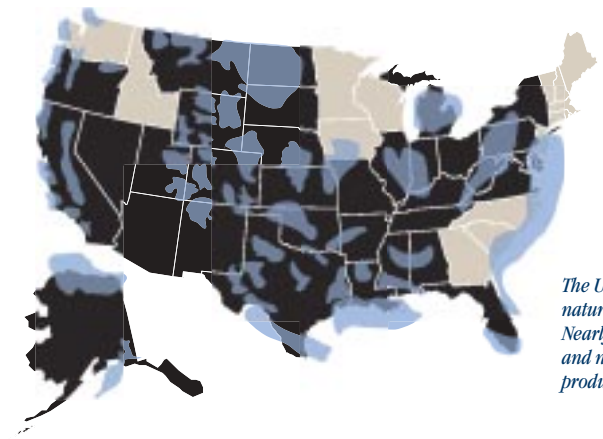
Source: American Association of Petroleum Geologists, Potential Gas Committee, U.S. Geological Survey and others.

Assessments of U.S. natural gas resources have grown over time. Fifteen years ago, many organizations estimated potentially recoverable U.S. gas resources at between 200 and 700 Tcf (adjusting to account for gas produced since the estimates were made). Today, most estimates range from 1,100 to over 1,400 Tcf, excluding Alaska.

Abundant natural gas resources

Despite being the most mature hydrocarbon-producing province in the world, the United States still holds vast natural gas resources that could provide supplies from settings such as the Alaska North Slope, deep formations, the deepwater offshore, and lower permeability formations in the Rocky Mountain States. At current rates of consumption, the Nation has at least 60 years worth of natural gas supplies that are recoverable with current technology. Moreover, as our knowledge of resource characteristics and the potential of new technology increases, estimates of the size of the resource base grow.

Natural gas is currently produced in over 30 States, and from a wide variety of geologic, geographic and environmental settings. Today, domestic supplies meet 84 percent of our Nation's natural gas requirements, with nearly all of the balance coming from Canada. But future natural gas consumption is expected to increase more rapidly than domestic production.



The U.S. is the world's second largest producer of natural gas and the third largest producer of oil. Nearly every region of the country has some oil and natural gas supply potential (blue). States producing oil and gas today are shown in black.

New technology makes a difference

In the future, more of our domestic natural gas supplies must come from technically challenging resources and settings, continuing the historical trend from onshore to offshore marine environments, from shallow to deeper formations, and from conventional to more unconventional resources.

Through technology innovation, industry is:

Accessing new frontiers. Prospects can now be drilled in waters two miles deep, as much as six miles into the earth, in the cold frontiers of the Arctic, and in coal seams, areas thought uneconomic to pursue not too many years ago.

Finding natural gas more efficiently. Drilling success rates have doubled in the last two decades, resulting in fewer dry holes, better exploration economics, and less environmental impact.

Finding natural gas

Geophysicists, geologists, and engineers search for onshore and offshore subsurface reservoirs of natural gas. New technologies like seismic imaging and remote sensing have raised the odds that exploratory wells will be successful and enable gas resources to virtually be seen thousands of feet below the earth's surface.

- *In exploring for natural gas, prospectors often still must drill 3 to 10 unsuccessful wells for each successful one, though success rates are improving markedly.*

Finding more oil and gas per wells drilled. Today, fewer than half as many wells must be drilled to locate the same amount of natural gas as two decades ago.

Decreasing costs. In inflation-adjusted dollars, wells can be drilled today to the same depth at a cost 10 to 20 percent cheaper than in the 1980s.

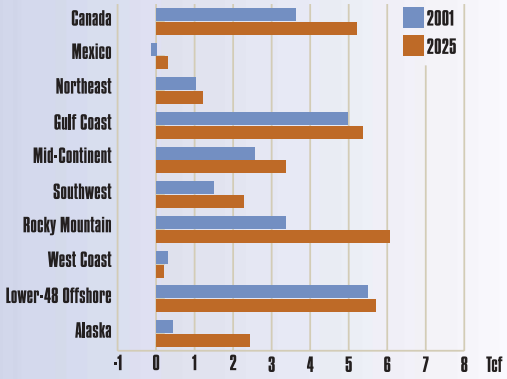
Extracting more from discovered fields. Enhanced recovery technologies continually allow industry to access and produce a higher proportion of the natural gas in discovered reservoirs, leaving less behind.

Shrinking the footprint. Substantial gains have been made in minimizing the surface area of oil and gas exploration and production operations.

As a result of these innovations, the United States has been able to replace the natural gas supplies it has produced for seven of the past eight years. However, new technologies have also increased the rate at which new gas wells are depleted, requiring a greater pace of drilling to maintain production levels. Depletion has been less pronounced for natural gas produced from unconventional resources, such as tight sands and coal seams, which comprise an increasing share of new gas finds.

Supply challenges remain

Key challenges must be addressed to ensure abundant future natural gas supplies. Technology progress must continue, requiring continued support for research and deployment of new advances. Past public policy decisions have placed a substantial portion of domestic natural gas resources off-limits or constrained development, limiting supplies. We must increase our natural gas supplies while protecting and improving the environment.



Increasing domestic supplies

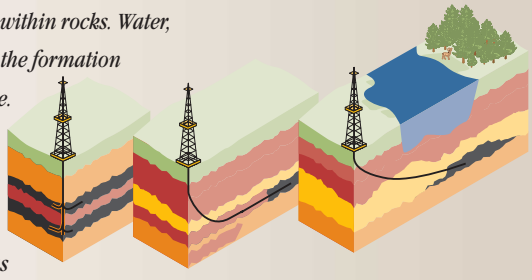
Growing U.S. demand for natural gas must be met by increased domestic supplies — primarily from Rocky Mountain States and Alaska, the onshore and offshore Gulf Coast and Mid-continent — along with increased imports from Canada and overseas sources of liquefied natural gas (LNG).

Source: Energy Information Administration

Developing natural gas

Resources can be accessed through vertical, horizontal, or directional drilling, with well bores probing in multiple directions. Gas resides in pore spaces within rocks. Water, sand, or other materials injected into the formation improve the flow of gas to the wellbore.

- *A well can cost anywhere from less than $100,000 to several million to drill.*
- *About 10,000 to 15,000 natural gas wells are drilled each year in the U.S.*
- *Federal, State and local governments, Tribes, and private landowners receive over $8 billion each year in revenues from natural gas leases and production.*



Producing natural gas

Natural gas may be produced using natural pressure in the reservoir, or by pumping devices. Recovery can be improved with secondary recovery techniques such as advanced reservoir characterization, which identifies new production zones or bypassed compartments. Specialized equipment separates well fluids into natural gas, liquid hydrocarbons, and water.

- *Over 7,000 small independent businesses drill 85% of wells and produce 65% of natural gas in the U.S.*
- *In 2001, about 19.5 Tcf of natural gas was produced from over 350,000 U.S. wells. Most production came from Texas (26%), Gulf of Mexico Federal offshore (25%), New Mexico (8%), and Oklahoma, Louisiana, and Wyoming (7% each).*

Getting Natural Gas to Market

In its natural form, natural gas has no color, taste, or smell. Industry adds small amounts of the chemical mercaptan to provide the familiar odor associated with gas, which enables leak detection.

Long journey to market

The complexity of the natural gas business often goes unnoticed by those benefiting from this fuel. Once produced, natural gas must make a journey from the wellhead to where it is consumed. The gas is gathered at a central location, processed to meet pipeline specifications, transported through thousands of miles of interstate pipelines, stored in the ground for when it is needed, then delivered to the "city gate," and, finally, to the consumer.

Gas demand changes over time

Natural gas demand, and therefore gas prices, can vary due to factors such as weather, the costs of alternative sources of energy or feedstocks, and the ability of consumers to reduce use when necessary. The Nation's natural gas delivery system must respond accordingly. Storage volumes can be used to meet seasonal demands (base-load storage) and short-term peaks in demand (peaking storage) that can range from a few hours to a few days.

During the 2000 - 2001 heating season, natural gas prices ranged from $2 to $10 per Mcf. More recently, prices have ranged from $3 to $6, peaking to above $10 per Mcf for short periods. As the market responded to sustained cold weather during the 2002-2003 heating season and to flat or declining production, natural gas prices remained above $5 per Mcf on a monthly basis through mid-2003.

Gathering & processing

Natural gas is gathered from individual wells to a central point, and then some must be processed to meet pipeline specifications. Processing involves the removal of such impurities as sulfur, carbon dioxide, and/or nitrogen that can be sold as byproducts, and the recovery of high-quality natural gas liquids including propane and butane.

- *An estimated 34% of U.S. gas production does not meet pipeline specifications.*
- *Over 580 U.S. plants process almost 17 Tcf of natural gas, extracting 720 million barrels of natural gas liquids in the process.*

Transportation

Nearly all natural gas in the U.S. is transported, often over long distances, through interstate pipelines. These pipelines, ranging from 20 to 42 inches in diameter, move large amounts of gas with the help of compressors every 70 miles or so to boost line pressure along the way.

- *About 80 natural gas pipeline companies transport natural gas through this network.*
- *Existing capacity is capable of transporting over 133 Bcf of gas per day.*

Storage & distribution

Local distribution companies are the Nation's "city streets" for natural gas, delivering gas to every consumer. Some natural gas is stored underground for use when demand is unusually high, such as on very cold days. Storage accounts for about 20% of natural gas consumed each winter.

- *More than 110 gas storage operators control over 415 underground storage facilities, with a working gas capacity of 3.9 Tcf, and an average daily deliverability of 78 Bcf per day.*
- *1,200 local distribution companies, with over 150,000 employees, deliver natural gas through one million miles of distribution lines to 175 million customers in all 50 States.*

Nearly all natural gas in the United States is moved via pipeline. The existing delivery system includes about 212,000 miles of interstate transmission lines.

Expanding natural gas infrastructure

Although the Nation has an extensive natural gas delivery system, it will need to maintain and expand the system to meet market requirements in the longer term. Foremost will be new interstate pipeline capacity from Alaska, Canada, and the Rocky Mountain States, where large quantities of natural gas are known to exist, but where access to markets is currently limited. In 1999, the National Petroleum Council estimated that 38,000 miles of new interstate gas transmission lines and 255,000 miles of new gas distribution lines could be required to meet future natural gas demand by 2015, requiring investment approaching $1 trillion. Shifts in market requirements will create a need for more storage capacity. Currently, depleted oil and gas fields provide over 85 percent of the Nation's gas storage capacity.

Substantial investments may also be required to enable LNG imports to make a significantly greater contribution to North American gas supplies. Worldwide demand for LNG is growing, which could increase competition for available supplies. The United States currently gets a majority of its LNG via ocean tanker from Trinidad and Tobago, Qatar, and Algeria, and also receives shipments from Nigeria, Oman, Australia, Indonesia, and the United Arab Emirates. The United States imported 0.23 Tcf of LNG in 2000.

Expediting the siting and permitting of new pipeline, storage, and LNG facilities will be necessary to meet the market's requirements in a timely manner.

Maintaining safety and integrity

Federal, State, and local government agencies oversee all phases of industry activities, and work cooperatively with industry to ensure the safety and integrity of the Nation's natural gas delivery system. Interstate pipeline companies are regulated in the rates they charge, the access they offer to their pipelines, and the siting and construction of new pipelines. Similarly, local distribution companies are regulated by State utility commissions, which oversee their rates and construction issues, and ensure proper procedures exist for maintaining adequate supply to their customers. Industry establishes business standards for sales and marketing of natural gas, and works to ensure the safety, integrity, and security of this critical infrastructure.

Did you know

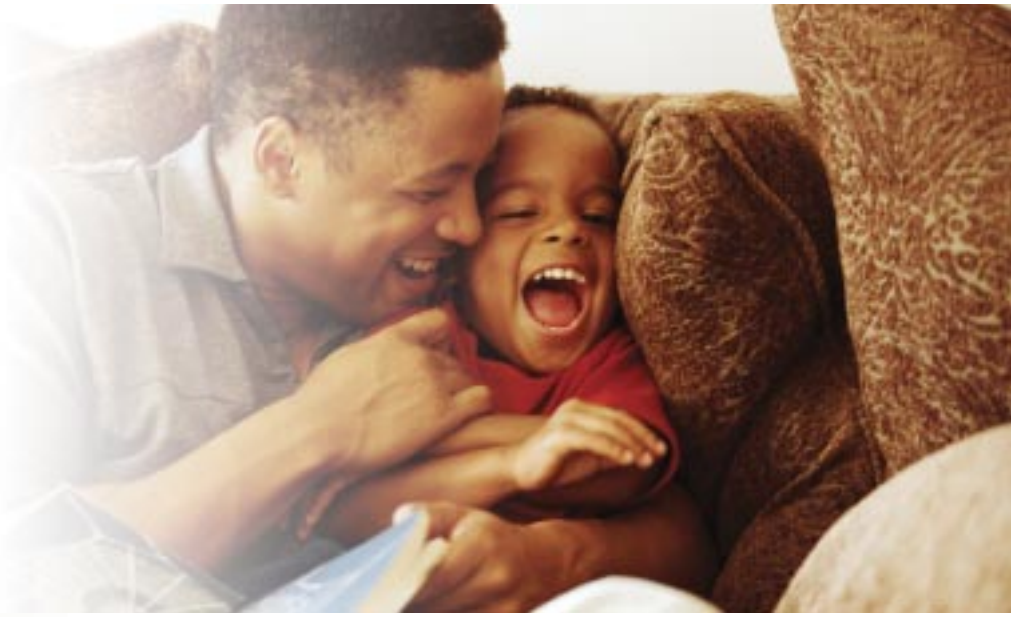
Nationwide, natural gas is used in:

- *78% of restaurant facilities*
- *73% of lodging facilities, with 50% using gas for space heating*
- *51% of hospitals*
- *59% of office buildings*
- *58% of retail buildings*

Uncertainties of supply and demand

Forecasting the dynamics of the energy marketplace is not an exact science, and is often limited by data availability. Future natural gas supply, demand, and price will depend on many real-life factors, including choices made by industry, government, and American consumers. The Nation faces serious energy challenges, and increasing our understanding of these challenges will enable informed decisions affecting our future prosperity.

Liquefied natural gas (LNG) is becoming a more viable supply source, because of the large amount of low-cost natural gas resources around the world, and the significant decline in LNG costs. Siting new LNG import facilities is essential to bring more LNG to the United States.



Natural gas and our future

America's energy strength lies in the abundance and diversity of its energy resources. Natural gas is a critical component of the Nation's energy mix. Ensuring abundant, affordable, reliable natural gas for American consumers requires:

- *Efficient use and conservation of valuable natural gas in all its applications.*
- *Increasing supplies of natural gas from both domestic and international sources.*
- *Enhancing the Nation's natural gas delivery system to ensure the gas is available when and where it is needed.*

Select photos courtesy of: Pacific Northwest National Laboratory; Phillips Petroleum Company; Anadarko Petroleum Corporation; Petro-Canada; TransTexas Gas Corporation

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