

Fueling the Future



Natural Gas & New Technologies for the 21st Century www.fuelingthefuture.org

This is a synopsis of the "Fueling the Future" study which reveals that new gas technology will transform the way consumers use energy. It was conducted by Washington Policy and Analysis for the American Gas Foundation and released in February 2000.

Natural gas is the cleanest, most efficient fossil fuel. Increased use of natural gas could help the nation meet its environmental, economic and national security goals.

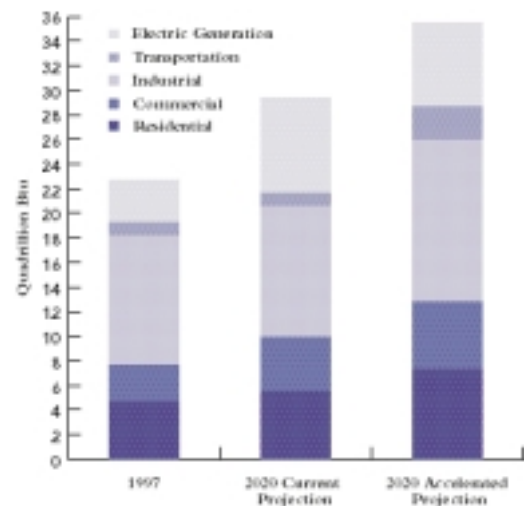
Role of Natural Gas Should Grow

The American Gas Foundation study, "Fueling the Future: Natural Gas & New Technologies for a Cleaner 21st Century," addresses a paradox that has faced the U.S. natural gas industry at least since the well-head price of natural gas was deregulated in the early 1980s: *How can a fuel that is domestically abundant, safe and reliable to deliver, more environmentally friendly than oil or coal, and over three times as efficient as electricity from the point of origin to the point of use, power only about one-fourth of the American economy?* This paradox is all the more puzzling given the fact that it has been national policy, as affirmed by successive U.S. presidents going back to Ronald Reagan, to encourage the broader use of natural gas.

"Fueling the Future" proves that a national energy policy encouraging the use of natural gas has not been fully realized. It then outlines a comprehensive overview showing how fulfilling the potential of natural gas would help the United States better meet its energy needs for the next 20 years. Specifically, it addresses the questions of how much natural gas might be used and how, as well as what national benefits — environmental, economic, conservation — might result from such increased use.

Released in February 2000, the study forecasts that U.S. consumption of natural gas could rise more than 60 percent — from today's 22 quadrillion Btu (quads) to at least 35 quads over the next 20 years if national policy allows. The study examines two gas consumption scenarios: The "current projection" shows gas demand reaching just under 30 quads in 2020; the "accelerated projection" concludes demand could top 35 quads by 2020. Gas supply will keep up with demand, according to the study.

Natural Gas Consumption Forecasts





More Than Energy: Natural Gas' Powerful Advantages

Natural gas helps the United States meet more than its energy needs:

- ◆ Since natural gas is inherently cleaner-burning than other fossil fuels such as coal and oil, switching from those fuels to gas can help reduce greenhouse gas emissions, acid rain, smog, solid waste and water pollution.
- ◆ The efficiency of the natural gas system helps conserve the nation's energy resources. For instance, when the entire cycle of producing, processing and transporting energy is measured, natural gas is delivered to the consumer with a total energy efficiency of about 90 percent, compared with 27 percent for electricity. Further, natural gas appliances and equipment are extremely energy efficient.
- ◆ Natural gas is a reliable North American energy source. About 85 percent of the gas consumed each year in the United States is produced domestically. Most of the balance comes from Canada. On the other hand, nearly 60 percent of the oil used in the United States is imported, often from countries that are politically unstable.
- ◆ Natural gas is usually the most economical energy option.
- ◆ The reputation of the U.S. natural gas industry for safety and reliability is known worldwide. Over the past 10 years, safety-related incidents on the U.S. gas delivery system have declined by 38 percent even though the amount of gas delivered to customers has increased by nearly 25 percent. That's why countries from around the world send their experts to the United States to study its gas system.
- ◆ The natural gas industry helps fuel the nation's economy by employing hundreds of thousands of workers — 150,000 on the utility side alone. Moreover, based on data from the U.S. Department of Commerce, every \$1 million in revenue generated by gas utilities increases national economic output by \$2.66 million, and employee earnings by \$450,000.

New Technologies Interest Business Owners

By 2020, the businesses and institutions making up the commercial sector of the energy market will require more natural gas in their operations, up to 5.5 quads. Of the 7.7 quads of energy currently used in this sector, natural gas holds a 40 percent market share, with electricity accounting for slightly more. Right now, gas is the dominant source of energy for heating, water heating, cooking and drying, and that is not expected to change.

In addition to traditional uses for heating and cooking, a number of innovative gas-fueled technologies — especially cooling and distributed generation — are expected to account for a large portion of the

increase in gas consumption in this market over the next 20 years.

Two variations on distributed generation that do more than just generate electricity are forecast to contribute to the growth of commercial-sector gas demand. Combined heat and power systems (CHP) and combined cooling, heat and power systems, which both use a single source of energy, such as natural gas, to produce these multiple products are expected to prove popular with businesses and institutions.



Chicago's Brookfield Zoo relies on natural gas-fueled cogeneration to produce two-thirds of its electricity, ensuring the welfare of its many inhabitants.

Natural Gas Warms More Homes

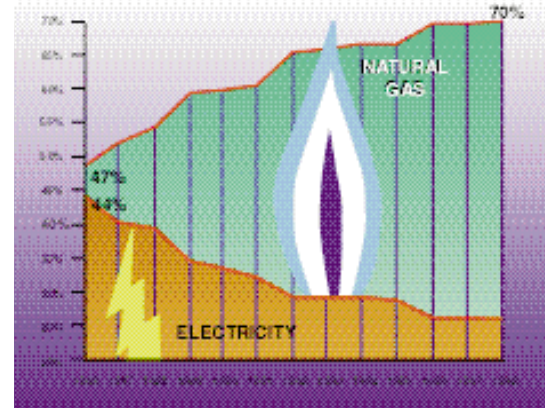
Today, 56 million U.S. households — 55 percent of all U.S. homes — have natural gas service. In the American Gas Foundation forecast, household use of gas increases, rising to 7.4 quads.

The study notes that consumers will continue to favor natural gas by a wide margin over electricity for the heating systems installed in their new homes. Of the single-family homes built in 1998, 70 percent have gas heat — up from 47 percent in 1986.

The forecast also assumes that owners of existing homes will continue to convert their heating systems from other fuels to natural gas — about 200,000 homeowners a year converted their heating systems from other fuels to gas during the 1990s.

In addition, the study sees a significant potential for conversions of other household tasks to natural gas in homes already hooked to the gas system. Consumers are well aware that gas provides warmer air for heating, more precise temperature control for cooking and a quicker recovery for water heaters.

There is also great potential among the less traditional uses of gas, including fireplaces, air conditioners, and distributed generation.



Natural gas continues to dominate the new-home heating market, warming 70 percent of the single-family homes built in 1998.

Distributed Generation Fuels Natural Gas Demand

The American Gas Foundation forecast attributes much of the future growth in overall gas demand to widespread use of gas-fueled distributed generation technologies, some of which are already on the market. The evolution of distributed generation systems will continue, says the study, making this technology a viable option for a greater number of homes, businesses and factories.

Distributed generation refers to the placement of small-scale power-generation units at or near the site where electricity will be used. Natural gas is a particularly attractive fuel for distributed generation, and it powers most of today's distributed generation systems, which range from fuel cells that generate electricity for individual homes and small businesses to gas-fueled turbines and reciprocating engines that produce electricity for factories.

Compared with a central-station power plant, a distributed generation unit produces fewer pollutants, is more energy-efficient and more reliable, is resistant to power outages, produces the high-quality electricity required for high-tech applications and gives consumers greater control over energy use.



Fuel Cells Come Home

Gas-based distributed generation has the potential to radically alter the residential market. Rather than purchasing electricity from distant generating plants, residential customers can use natural gas to produce electricity at their homes through very small gas turbines (microturbines), or fuel cells.

A fuel cell is a self-contained unit that converts natural gas to electricity and heat through a chemical reaction.

Fuel cells are energy efficient, and they can reduce a number of pollutants, including carbon dioxide and nitrogen oxides—with no discharge. A limited number of residential fuel cells are in use today, including the 7 kW residential PEM fuel cell installed by Plug Power in the house pictured above, with installed costs ranging from \$7,000 to \$10,000. Mass production could cut the cost in half within the timeframe of this study.

Powering Up With Natural Gas

Fuel for a Cleaner Environment

Even though coal is expected to remain the dominant power plant fuel, the amount of natural gas consumed by electric utility and non-utility power plants is expected to more than double over the next two decades from today's 3.3 quads, according to the American Gas Foundation study. The main reason is that natural gas offers important environmental, economic and technological advantages that competing fuels do not.

However, the study forecasts less construction of new power plants than some other studies because:

- ◆ the lives of some coal-fired and nuclear-powered generation plants will be extended,
- ◆ some new coal-fired generating plants will be built,
- ◆ distributed generation systems will account for 20 percent of generating capacity additions,
- ◆ renewable sources of energy, such as solar and wind will generate more electricity in 2020 than today.

The availability of combined-cycle technology is one reason why gas demand to generate electricity has grown recently and will continue to grow in the future. A gas-fired combined-cycle power plant is almost twice as efficient as conventional boiler units.

This higher efficiency means less pollution. Replacing a coal-fired electricity generating unit with a typical gas-fired combined-cycle unit can eliminate acid-rain-producing sulfur dioxide emissions, reduce carbon dioxide (a greenhouse gas) emissions by 66 percent and cut smog-forming nitrogen oxide emissions by 95 percent.

Industry Fueled by Natural Gas

Natural gas is the primary source of energy for the nation's factories, accounting for nearly 40 percent of the energy used in the industrial sector. Gas demand in this market totaled 10.1 quads in 1998. The American Gas Foundation study projects that demand in 2020 could reach 13 quads.

Much of the energy demand in this market is based on the need for heat and electricity. Both electricity and heat can be produced in a single energy-efficient and clean process called cogeneration, a form of distributed generation. In the coming years, natural gas demand growth will come from technological advances that have emanated from cogeneration-related technology, including new breeds of gas turbines, reciprocating engines and heat-recovery equipment.

In addition, gas demand growth also will be spurred by the efforts of industry to improve energy efficiency and meet environmental standards. "Upgrade" efforts will stimulate development of new processes and equipment, such as gas-fueled direct-contact water heaters and gas-fired infrared burners, which are three or more times as clean and efficient as the equipment they replace.



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Technological Advances Rev Up NGV Market

Vehicles are responsible for about one-third of all carbon dioxide and nitrogen oxide emissions and about half of all carbon monoxide emissions. Using natural gas in place of gasoline and diesel fuel not only greatly lowers the vehicular emissions that pollute the air, but it also reduces U.S. dependence on imported oil.

The amount of natural gas used to fuel vehicles is forecast to reach 1.5 quads by 2020 under the American Gas Foundation's accelerated projection, as federal, state and municipal governments continue to work on improving air quality.

An All-American, Abundant Fuel

The North American natural gas resource base — the amount of gas that supply experts believe remains in the ground ready to be produced—is vast and diverse, and it can support substantial increases in gas use through the 21st century and beyond. As U.S. gas demand rises, the pattern of supply will remain nearly the same, with about 85 percent produced domestically and the balance imported primarily from Canada.

More than 19 quads of natural gas were produced in the United States in 1998. If the technologies used to find and produce gas continue to improve as rapidly in the next two decades as they did in the past decade, yearly domestic production could reach 29.5 quads by 2020. This production level, supplemented by modest amounts of imported gas (largely Canadian), is sufficient to sustain the 35 quads of demand envisioned under the American Gas Foundation's accelerated projection.

Major advances in exploration and production technologies during the 1990s opened up gas resources in areas that were previously unreachable or simply not economical to tap. Similar technological leaps are expected to occur over the next 20 years.



Nearly 80,000 natural gas vehicles (NGVs) are being driven today in the United States, mainly as fleet vehicles. Bus, truck and car fleets in areas with air-quality problems offer the most promising markets for NGVs, in part because fleet vehicles travel many miles daily, and they can take full advantage of the lower cost of natural gas. Fleet operators can also install a natural gas fueling station at a central location, such as the fleet garage or parking lot.



The study notes that the gas resource base in Alaska is quite large, but it has not yet been necessary to tap this supply source, and no delivery system is in place to move the gas to the lower 48 states. The prospects for transporting Alaskan gas southward, however, are improving because the natural gas infrastructure in Canada is growing toward Alaska.

Consumers paid about 24 percent less for natural gas in 1998 than they did in 1987 (in inflation-adjusted dollars).

Some Investment Needed to Expand Gas Infrastructure

Accommodating a demand level of 35 quads will require major expansion of the gas infrastructure, which includes wells, processing plants, long-distance pipelines, utility mains and storage facilities. The American Gas Foundation study estimates expansion of the pipeline and utility system alone will cost \$150 billion, with two-thirds of this total accounted for by local gas utility expansion.

To provide at least 35 quads of gas by 2020, the number of oil and gas wells drilled each year may have to double from today's level to 50,000 wells a year. Although a challenge, this level is well below the record set in the early 1980s, when 70,000 to 90,000 wells were drilled annually.

Projects required to produce and deliver natural gas can be delayed unnecessarily by cumbersome government regulation. In addition, regulations could be more effective if they recognized the positive impacts of new gas-related technologies. For example, a significant portion of the gas resource base is restricted to drilling based on regulations put in place decades ago. These regulations do not recognize the industry's technological advances. Similarly, advances in gas transmission and distribution systems should be recognized — from ultra-quiet compressors to high-pressure plastic pipe.



GARY MALMAY

Gas Prices to Remain a Great Energy Value



The combination of a deregulated energy market, the continued expansion of the gas resource base and further technological improvements in the way we produce and deliver gas will ensure that gas prices increase only modestly over the next 20 years, according to the American Gas Foundation study. The price of gas purchased at the wellhead, which was deregulated in the 1980s, can remain in the mid-\$2 per MMBtu range, leaving gas bills for residential, commercial and

industrial customers relatively constant (when future inflation is taken into account). The price of gas to fuel central-station power plants may rise somewhat from today's level.