CHAPTER 5
Natural Gas

INTRODUCTION

Natural gas is one of the most abundant energy sources in the world. Like oil, it is created by the decomposition of organic matter. The lightest of all hydrocarbons, natural gas is commonly found in underground formations either by itself; associated with or lying atop oil deposits; or dissolved in crude oil.

Once burned as an oilfield waste product, natural gas now supplies the U.S. with 22.5 percent of its energy, as measured by British thermal units (Btu).[1] Texas is the nation's largest producer and consumer of natural gas, providing one-fourth of U.S. supplies and consuming one-sixth, primarily in the industrial and electricity generation sectors.[2]

Natural gas imports via pipeline from Canada and Mexico, as well as liquefied natural gas (LNG) imports from overseas, now provide 19 percent of total U.S. supplies.[3] Texas is the entry point for up to two-thirds of Mexican gas imported by pipeline, with a capacity of 2,485 million cubic feet (MMcf) daily.[4]

Natural gas, along with crude oil, is a major economic boon to Texas. Combined, these two energy sources accounted for 14.9 percent or $159.3 billion of the 2006 Texas gross state product (GSP).

History

The practical use of natural gas dates back to the Chinese of 2,500 years ago, who used bamboo pipes to collect it from natural seeps and convey it to gas-fired evaporators, where it was used to boil ocean water for the salt. French explorers in the early 17th century found Native Americans around the Great Lakes burning gas from natural seeps for cooking. As inexpensive cast-iron pipe became available in the 19th century, natural gas derived from coal became a relatively common fuel for street lighting in some U.S. cities.[5]

As the technology to create seamless steel pipe and related equipment advanced, the size and length of pipelines increased, as did the volumes of gas that could be transported easily and safely over many miles. The first natural gas pipeline longer than 200 miles was built in 1925, from Louisiana to Texas.[6]

The first long-line interstate pipelines were built in the 1930s to ship crude oil, not natural gas, from Texas and Oklahoma to the Midwest. Because natural gas is created from the same materials by the same processes as oil, natural gas often is encountered in oil drilling. Before the mid-1940s, it was an unwanted byproduct and was simply flared (burned off) in the field. As concerns about field conservation grew, Texas banned flaring after World War II, so producers had to find markets for gas.[7]

During World War II, the War Production Board approved other long-line crude oil pipelines from Texas to the East Coast, to avoid the threat to oil tankers from Nazi submarines. After the war, the government allowed these pipelines to carry natural gas instead of crude oil, which they do to this day.[8] U.S. demand for natural gas rose rapidly thereafter. Residential demand grew 50-fold between 1906 and 1970.[9]

Today, natural gas has become extremely important as a concentrated, clean fuel for home heating and cooking and electrical power generation, and is sought after almost as much as oil.

Uses

Natural gas is in fact a generic name for several gases. The natural gas that is piped into our homes, business and electricity generation plants is primarily methane, an odorless, colorless, lighter-than-air gas.[10] When produced from an underground formation, natural gas commonly contains other compounds, including slightly heavier hydrocarbon gases such as propane and butane, water and sulphurous compounds, and is known as "wet gas" (**Exhibit 5-1**).

"Casinghead gas" is the gas that appears with crude oil, often dissolved in it; "gas well gas"

Texas is the nation's largest producer and consumer of natural gas, providing one-fourth of U.S. supplies and consuming one-sixth, primarily in the industrial and electricity generation sectors.

comes from gas-only formations; and "coal seam" or "coal bed" gas is found in coal formations. Natural gas is also a byproduct of refined crude oil. In addition, many fossil fuels and other carbon-containing materials, such as coal and coke, can be gasified to produce natural gas.

Natural gas is a proven, reliable and clean fuel that has provided Texas not only with abundant and relatively inexpensive energy supplies for more than a half-century, but also has provided the Texas economy with a reliable income.

According to the U.S. Department of Energy's Energy Information Administration (EIA), natural gas provided 33.9 percent of all Btu derived from domestically produced fossil fuels in 2006; 26.8 percent of the Btu from all fuels domestically produced, including nuclear and biofuels; and 22.5 percent of Btu derived from the total U.S. energy supply.[11]

Natural gas is a versatile fuel and very simple to use, as it can be burned or used either as feedstock for other products or to power fuel cells. It is the fuel of choice for most Texas electric utilities, which use it to boil water to produce steam, turn turbines and generate electricity. EIA reports that one cubic foot of natural gas at normal pipeline pressure and temperature produces about 1,031 Btu, roughly the same Btu content as 1.3 ounces of high-grade coal.[12]

Natural Gas in Texas

Natural gas is a proven, reliable and clean fuel that has provided Texas not only with abundant and relatively inexpensive energy supplies for more than a half-century, but also has provided the Texas economy with a reliable income. In a world where other energy supplies have uncertain futures, natural gas remains a popular, dependable and, most importantly, domestically produced fuel.

EXHIBIT 5-1
Typical Composition of Natural Gas

Chemical Component	Chemical Composition	Proportion of Natural Gas
Methane	CH_4	70-90%
Ethane	C_2H_6	0-20
Propane	C_3H_8	
Butane	C_4H_{10}	
Carbon Dioxide	CO_2	0-8
Oxygen	O_2	0-0.2
Nitrogen	N_2	0-5
Hydrogen sulphide	H_2S	0-5
Rare gases*	Ar, He, Ne, Xe	trace

*Argon, helium, neon, xenon.
Source: Natural Gas Supply Association.

Economic Impact

As noted in earlier chapters, the federal and state governments combine oil and natural gas data for various statistics because of the high degree of overlap between the two. In 2006, more than 312,000 Texans, or 3.1 percent of the state work force, were employed in the oil and natural gas industry, which accounted for more than $159 billion or 14.9 percent of Texas' gross state product (GSP). Oil and gas industry wages totaled $30.6 billion in that year, or about 6.9 percent of all wages in Texas. Per employee, the industry contributed $511,000 to the GSP. This compares very favorably with the 2003 GSP per employee of $319,000.[13]

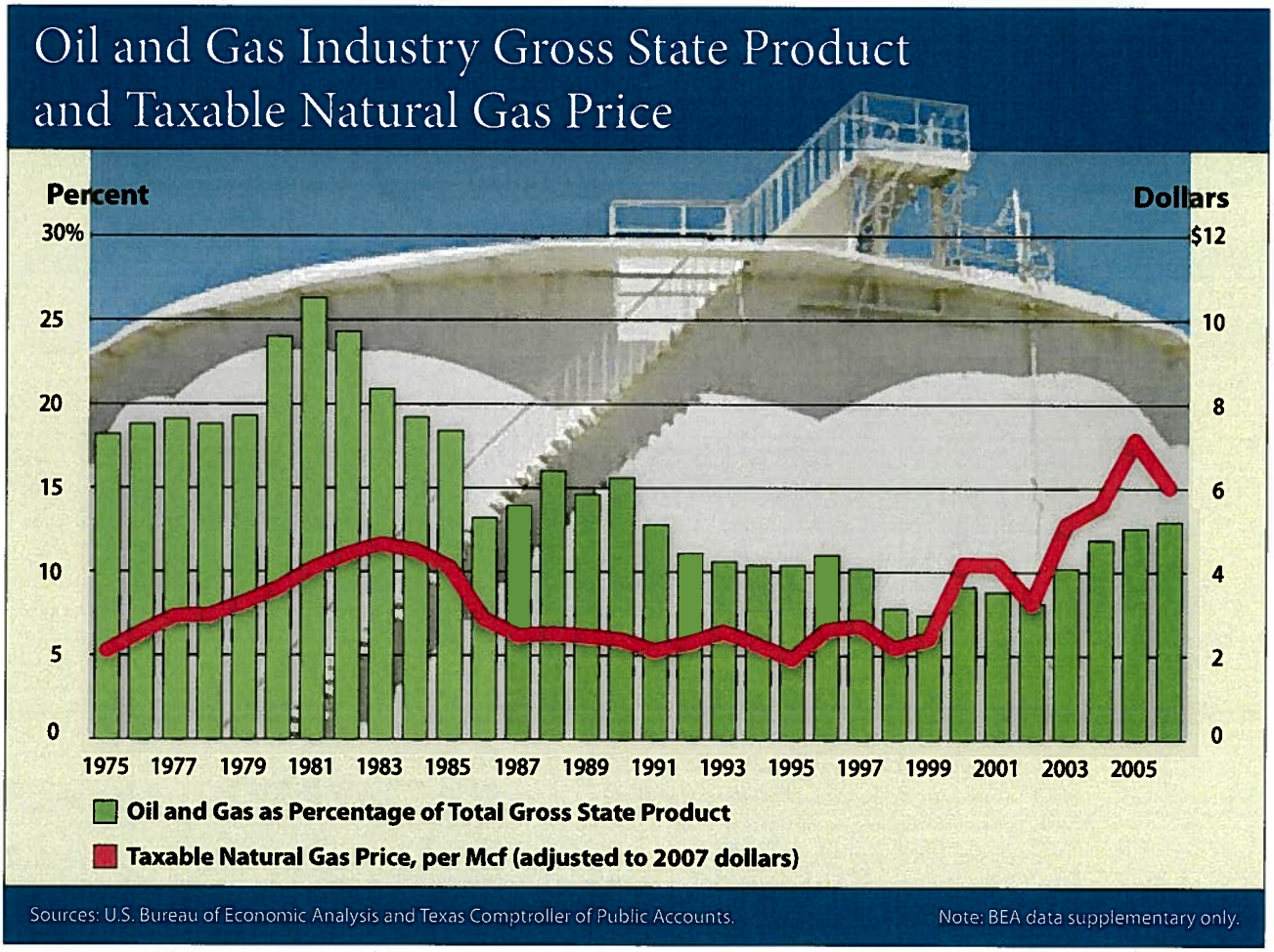
Historically, the oil and natural gas industry have accounted for approximately 10 percent to 25 percent of the state's GSP (**Exhibit 5-2**). (The price indicated in the exhibit is based on the taxable value of gas from in-state production, in dollars adjusted for inflation.) However, compared to the relatively close relationship between the real price of oil and the industry's contribution to the state's GSP (see **Exhibit 4-2** in Chapter 4), the real price of natural gas is slightly less volatile and does not appear to track GSP closely.

Consumption

According to the Electric Reliability Council of Texas (ERCOT), which operates the largest of Texas' four electric grids, natural gas could provide about 72 percent of its total electric generation capacity if used at maximum output every hour of every day. But because cheaper fuel alternatives often are used when available, and plants are often down for maintenance and repair, Texas electric generators used natural gas to produce 46.6 percent of the electricity on the ERCOT grid in 2006 — still making it the most common fuel for electricity generation in the state.[14] (For more on Texas electricity, see Chapter 27 of this report.)

The price of natural gas sold to electric power consumers in November 2007 was $6.58 per Mcf,

EXHIBIT 5-2



about 42 percent below the post-Katrina and Rita high price of $11.30 in October 2005.[15]

According to 2006 EIA statewide data, natural gas is used as the primary energy source in 48 operating Texas utility plants with a total of 144 generators. The "nameplate" (maximum) capacity of these generators is 17,350 megawatts (MW). Seven other Texas plants, with a total 10 generators and 3,787 MW of nameplate capacity, use natural gas as a backup fuel.

Thirty of these plants are in ERCOT; three are in the Southeastern Reliability Council (SERC) grid (in southeastern Texas); 13 are in the Southwest Power Pool (SPP) grid (covering the western and northern Panhandle and the Texarkana area); and two are in the Western Electric Coordinating Council (WECC) electricity grid (in far West Texas) (**Exhibit 5-3**).[16]

Private industrial plants also use natural gas to generate electricity for their own consumption. Some of these plants are owned by a wide variety of manufacturers and processors, such as Alcoa World Alumina, LLC, E. I. DuPont De Nemours & Co. and ExxonMobil.[17]

To reduce vehicle air emissions, the Texas Department of Transportation (TxDOT) uses natural gas and propane (a liquefied petroleum gas, or LPG) as fuel to power about 4,500 fleet vehicles and buses, which reduced its fiscal 2005 gasoline consumption by five million gallons, or 0.4 percent of the state's gasoline consumption that year.[18] In that year, all natural gas vehicles in Texas consumed

EXHIBIT 5-3
Natural Gas-Powered Generation in Texas, 2006, By Grid

	Total Plants	Total Generation Units	Utility-Owned Plants	Utility-Owned Generation Units	Natural Gas-Driven, Utility-Owned Generation Plants	Natural Gas-driven, Utility-Owned Generation Units
ERCOT	217	698	59	164	30	92
SERC	18	65	3	9	3	9
SPP	36	78	19	49	13	36
WECC	6	18	3	8	2	7
State Total	**277**	**859**	**84**	**230**	**48**	**144**

Sources: U.S. Energy Information Administration and Texas Comptroller of Public Accounts.

1,811 MMcf, less than one-tenth of 1 percent of the natural gas consumed in the state.[19] Since TxDOT's program began in 1993, it has replaced a total of 52 million gallons of gasoline with 52 million gallons of cleaner-burning alternative fuels.[20]

In addition to its merit as a fuel, natural gas is essential to the recovery of other hydrocarbons in underground formations. As a well is drilled into an oil accumulation pressurized by the weight of overlaying rock, the lighter gas expands in response to the release of pressure, forcing the oil downward in the formation and up the producing wells to the surface (**Exhibit 5-4**). For this reason, recovering all the natural gas in an oil field is not always a wise or economical idea. Other substances — water and injected non-hydrocarbon gas — can be used to artificially pressurize a formation, but often at substantial cost.

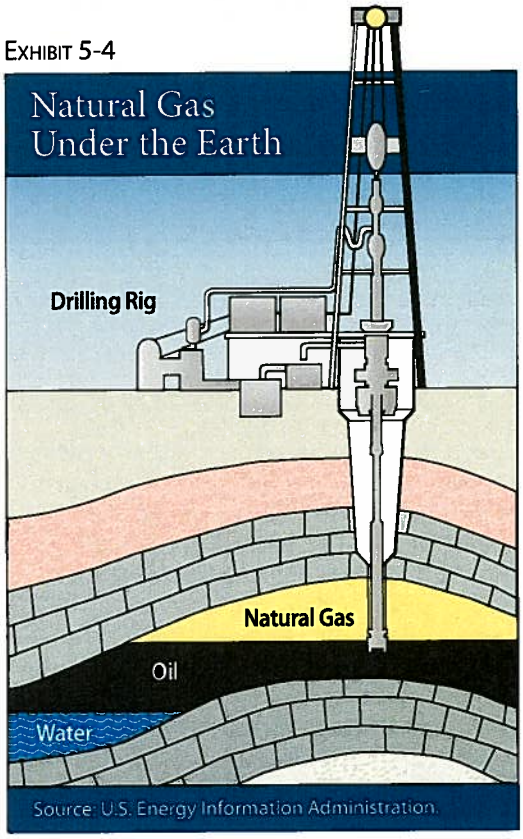
The industrial and electric power sectors dominate consumer natural gas demand in Texas, accounting for 90 percent of the state's use.

EIA data indicate that the U.S. consumed 21.7 trillion cubic feet of natural gas in 2006. Of that amount, 92.1 percent went to U.S. consumers; natural gas processors and pipelines used the remainder. Processors use natural gas to fuel the facilities that separate liquids from natural gas, while pipelines use natural gas to run the compressor engines that pressurize the gas, allowing it to travel hundreds of miles through the pipeline.

Of the consumer share, residential users accounted for 21.9 percent of gas supplies; commercial users consumed 14.2 percent; industrial users consumed 32.6 percent; and electric power generators used the remaining 31.2 percent.[21]

In 2006, Texas consumed more natural gas than any other state, or about 16 percent of total U.S. consumption. The industrial and electric power sectors dominate consumer natural gas demand in Texas, accounting for 90 percent of the state's use (**Exhibit 5-5**).[22]

EXHIBIT 5-4



Production

Natural gas is extracted through subsurface drilling. Natural gas does not require refining in the sense crude oil does, but it does require cleaning, due to the presence of other gases and liquids. These are removed at a gas processing plant where, as a safety measure, an odorant called mercaptan is added to the naturally odorless methane, giving it a distinctive rotten egg smell.

Four states — Texas, Louisiana, New Mexico and Oklahoma — and the Gulf of Mexico accounted for more than three-quarters of all natural gas produced in the U.S. until the late-1990s. In 2005, these four states plus Gulf production represented 68.4 percent of all U.S. production.[23] Texas natural gas production reached its peak in 1972, at more than 9.6 trillion cubic feet or more than 40 percent of all U.S. production.[24] In 2006, Texas produced more than 5.1 trillion cubic feet or 27.8 percent of all natural gas produced in the U.S., still more than any other state (**Exhibit 5-6**).[25]

Production in western states (California, Colorado, Montana, Nevada, Utah and Wyoming) has helped to make up for declining production from Texas, Louisiana, New Mexico and Oklahoma, while Alaskan production has remained steady (**Exhibit 5-7**).[26]

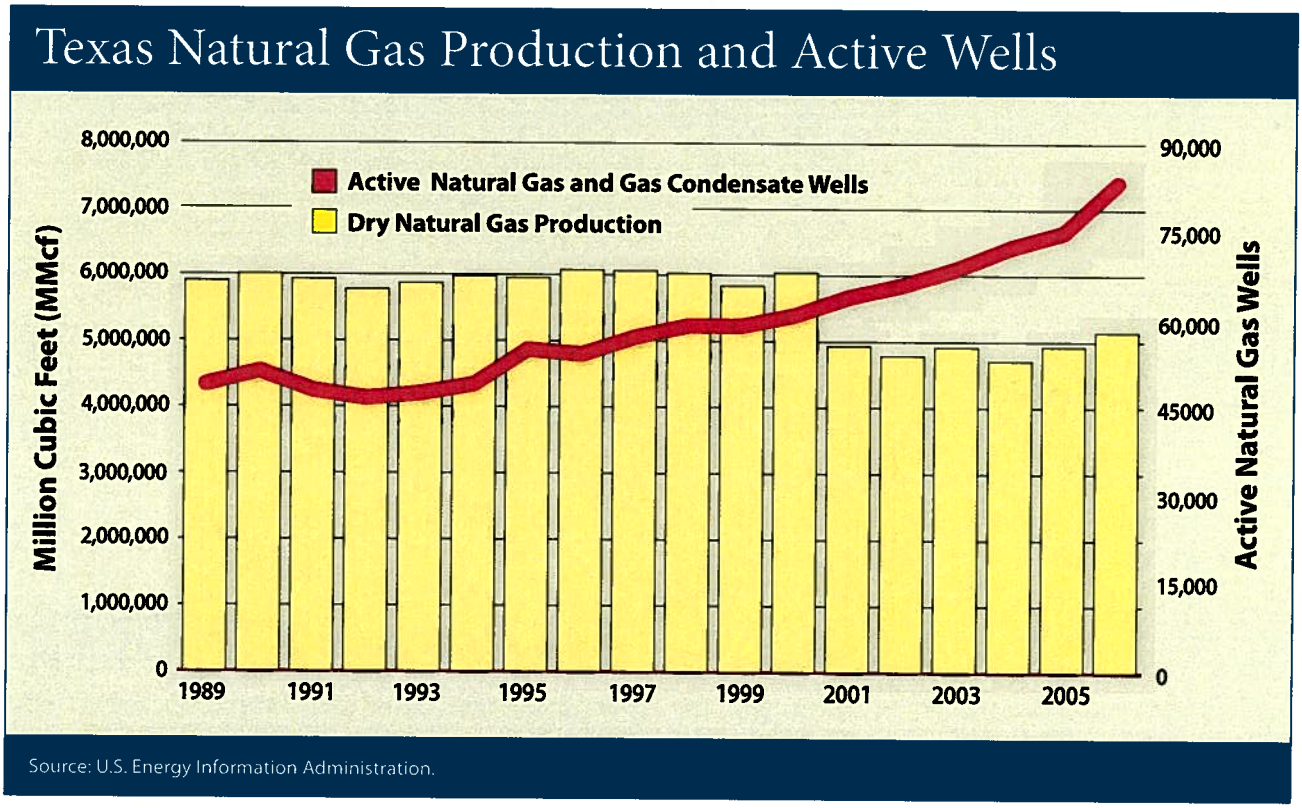
EXHIBIT 5-5

Texas Dry Natural Gas Consumption by End Use, 2006 (Millions of Cubic Feet [MMcf])

	2006 Total	Percent of Total
Residential	166,225	5.4%
Commercial	149,221	4.9
Industrial	1,288,510	42.0
Vehicle Fuel	1,972	<0.1
Electric Power	1,463,658	47.7
Total	**3,069,646**	

Sources: U.S. Energy Information Administration and Texas Comptroller of Public Accounts.

EXHIBIT 5-6



Source: U.S. Energy Information Administration.

In the 1980s, horizontal or "slant-hole" drilling came into widespread use in the prolific Austin Chalk (Giddings) gas fields east of Austin (**Exhibit 5-8**). This technique allows producers to drill vertically and then horizontally, to access multiple permeable zones associated with vertical geologic faults. In 1993, the chairman of Oryx Energy Co., at the time a major producer in the Austin Chalk, noted that the costs of drilling horizontal wells were about 50 percent higher than that for vertical wells, but the daily production was three to five times higher.[27] Gas production in the Austin Chalk formation was very high for several years, but has fallen slightly since.[28]

Today, horizontal drilling also is used in the Barnett Shale trend, extending south and west from Fort Worth over parts of 19 counties (**Exhibit 5-9**). The Barnett Shale is one of the most active natural gas production zones in the state and the nation. It contains more than 26 trillion cubic feet of natural gas locked up in a "tight" shale formation.[29] (A tight formation is one in which hydrocarbons are trapped in rock of particularly low permeability and low porosity.) Producers use large volumes of fresh water injected down hole to fracture or "frac" the shale and release the gas.

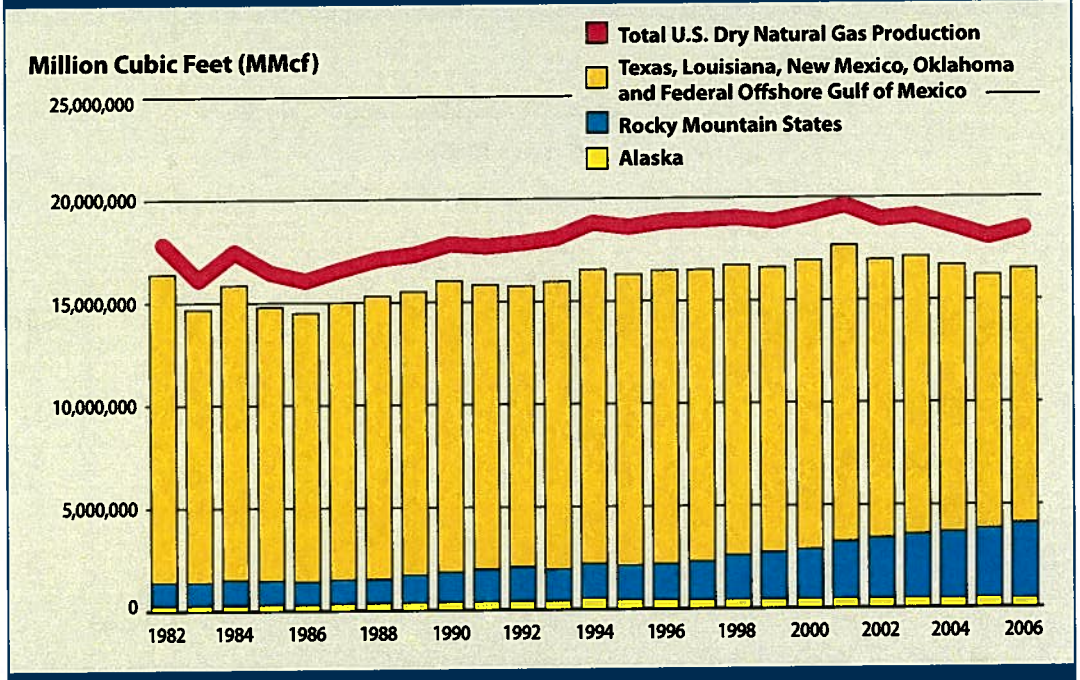
"Unconventional Gas"

The success of the Barnett Shale production zone has spurred efforts to produce gas in many other areas and geological formations that were previously considered unrecoverable or uneconomic. These "unconventional gas" sources include tight gas sands, shales and coalbeds. Producers have known about these unconventional resources for decades, but relatively low gas prices prevented their exploitation until recently. Unconventional gas production requires permeability enhancement of the reservoir rock, which is accomplished by "frac" techniques. Because of this requirement, each well may be more difficult and more expensive than regular drilling for conventional sources of gas. Only when natural gas prices are high does

The Barnett Shale is one of the most active natural gas production zones in the state and the nation.

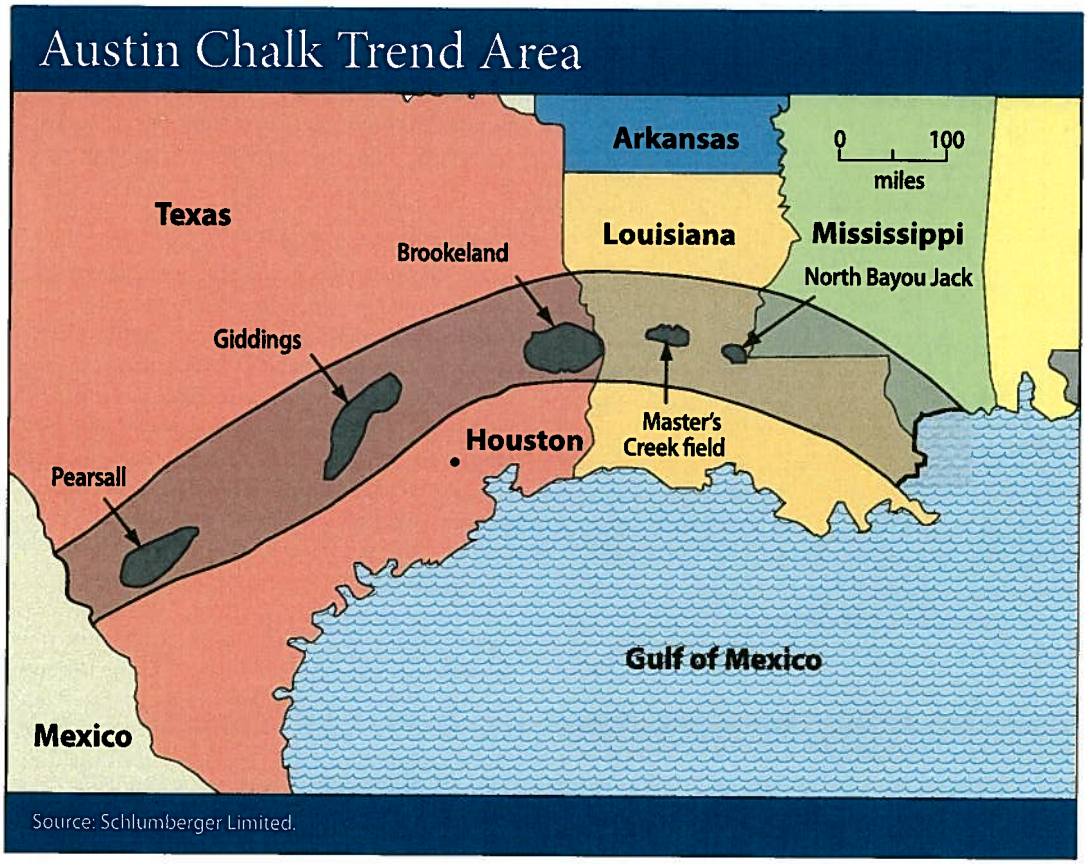
EXHIBIT 5-7

U.S. Domestic Dry Natural Gas Production



Sources: U.S. Energy Information Administration and Texas Comptroller of Public Accounts.

EXHIBIT 5-8



producing from unconventional sources become economically feasible.

Unconventional gas resources tend to cover large contiguous areas, however, creating economies of scale for operators who specialize in such drilling. Now that gas prices consistently are above $5-6 per Mcf, activity and production has increased dramatically. About 31 percent of current U.S. gas production comes from these unconventional resources. Many of the major unconventional gas fields in Texas (such as East Newark Barnett, Oak Hill Cotton Valley, Carthage Cotton Valley, Sawyer Canyon and Ozona Canyon) have significantly increased production in the past decade. Continued growth in unconventional gas production is expected in Texas and the U.S.[30]

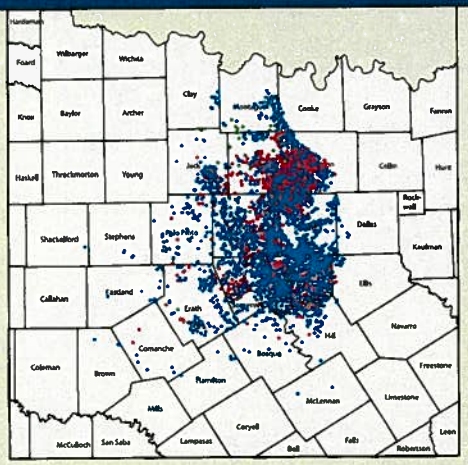
Gathering and Distribution

The first and smallest component of the pipeline system is a gathering line, generally less than eight inches in diameter, usually located in rural areas and operating under low pressure. Many states, including Texas, do not regulate these lines. Before the gas travels from the area of production, it is processed to remove liquids and non-hydrocarbon gases to become pipeline quality. It then is placed in ever-larger pipelines known as transmission lines, which can be up to 48 inches or more in diameter. These pipelines operate at higher pressures and if they cross state boundaries, become regulated by the Federal Energy Regulatory Commission (FERC).

As the gas nears its final points of sale, the pipeline diameters become smaller again, and are known as distribution lines. In energy parlance, interstate pipelines end at the "city gate," meaning at the pipeline terminus such as a utility or industrial facility, and the gas is sent to the end-user's "burner tip" through the utility's distribution lines.[31]

EXHIBIT 5-9

Operating Oil and Natural Gas Wells in the Barnett Shale



Source: Railroad Commission of Texas.

Some 215,000 miles of interstate pipelines deliver natural gas to every corner of the U.S., along with 87,000 miles of intrastate pipelines.

Interstate Pipeline Construction

Constructing a new interstate pipeline or expanding an existing one is a lengthy and complex undertaking — and an expensive one, too. Although construction costs per mile are extremely variable and site-specific, the Interstate Natural Gas Association of America estimates that new pipeline construction costs are approaching $3 million per mile and trending upward.[32]

Most of Texas' interstate pipelines follow the Gulf Coast to the Mississippi River, then diverge northward to serve the Midwest and northeastward to serve the East Coast. West Texas oil and gas fields generally deliver to the West Coast.

Some 215,000 miles of interstate pipelines deliver natural gas to every corner of the U.S., along with 87,000 miles of intrastate pipelines. Texas leads all states in its number of pipeline miles (**Exhibit 5-10**).[33]

Thirty-one states derive more than 80 percent of their natural gas from interstate pipelines.[34]

The U.S. also imports significant quantities of natural gas — more than 4.2 trillion cubic feet (Tcf) in 2006. Canadian pipeline imports represented more than 85 percent of 2006 U.S. imports.[35]

Exhibit 5-11 summarizes the natural gas industry's production, transmission and distribution system.

Storage and Disposal

Large, commercial volumes of natural gas are usually stored in underground rock formations with an impermeable cap, such as caverns in salt domes or depleted oil and gas reservoirs, or in large aboveground tank facilities. In 2007, Texas had 35 natural gas storage sites—20 in depleted reservoirs around the state and 15 in underground salt caverns along its coast (**Exhibit 5-12**). In all, Texas' natural gas storage capacity was 683.5 billion cubic feet in August 2007, placing the state fourth in the nation behind Michigan, Illinois and Pennsylvania.[36]

Texas's natural gas storage facilities allow the state to store its natural gas production during the summer months, when national demand typically is lower, and then ramp up delivery quickly during the winter months, when markets across the country require natural gas for home heating.

Due to the growing use of natural gas for electricity generation, however, Texas has occasionally withdrawn natural gas from storage during the summer to help meet the state's peak electricity demands due to high air conditioning use. Although the volume fluctuates constantly, from September 2006 to August 2007 Texas underground facilities averaged 575.8 Bcf of natural gas in storage, or about 8 percent of the U.S. total.[37]

Availability

Natural gas is widely available in Texas and the U.S. as a whole, due to many on- and offshore gas fields and an extensive drilling and pipeline infrastructure.

Texas is the nation's leading producer of natural gas, and in 2006 produced 5.1 trillion cubic feet, nearly half again as much as the state consumed (3.4 trillion cubic feet) and 27.8 percent of total U.S. marketed production.[38] Today, the Barnett Shale (Newark East) field in Northeast Texas is the second-largest natural gas field in the continental

EXHIBIT 5-10

Estimated Pipeline Mileage in Continental U.S., 2007

Western Region Pipeline Miles	
Arizona	5,989
California	11,770
Idaho	1,567
Nevada	1,469
Oregon	1,823
Washington	2,072
Total	24,690

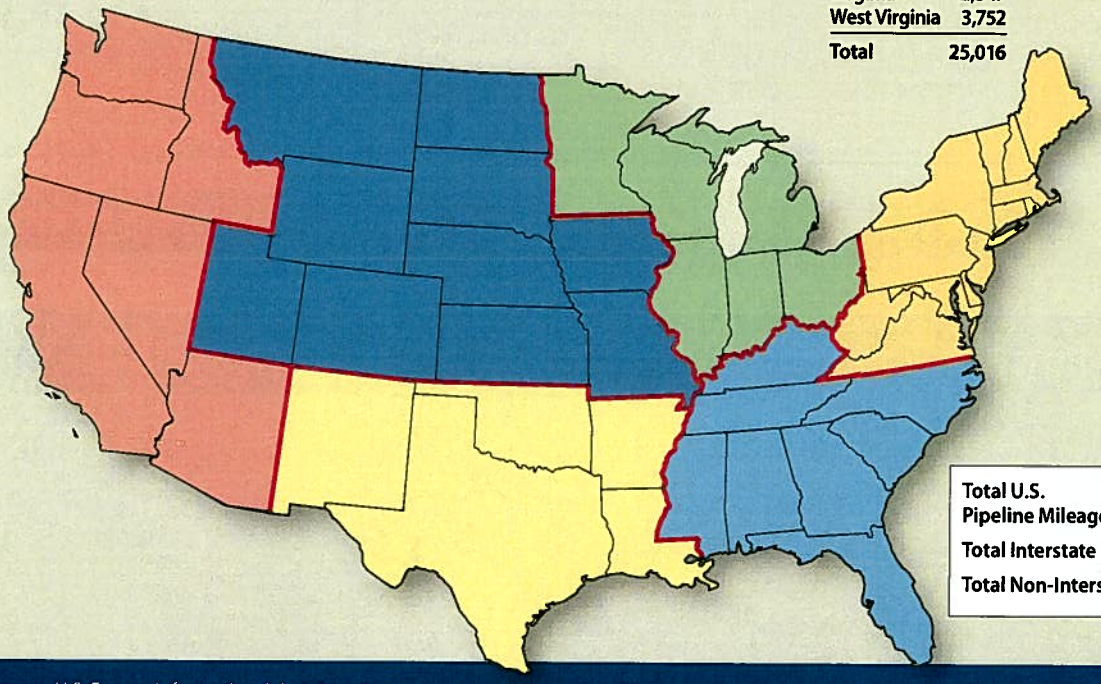
Central Region Pipeline Miles	
Colorado	7,465
Iowa	5,413
Kansas	15,286
Missouri	3,771
Montana	3,861
Nebraska	5,346
North Dakota	1,873
South Dakota	1,242
Utah	3,175
Wyoming	7,796
Total	55,228

Midwest Region Pipeline Miles	
Illinois	11,911
Indiana	4,704
Michigan	9,706
Minnesota	4,434
Ohio	7,666
Wisconsin	3,339
Total	41,760

Southeast Region Pipeline Miles	
Alabama	4,691
Florida	4,884
Georgia	3,483
Kentucky	6,824
Mississippi	9,484
North Carolina	2,484
South Carolina	2,265
Tennessee	4,273
Total	38,388

Northeast Region Pipeline Miles	
Connecticut	619
Delaware	273
Maine	607
Maryland/DC	972
Massachusetts	959
New Hampshire	291
New Jersey	1,516
New York	4,741
Pennsylvania	8,586
Rhode Island	100
Vermont	53
Virginia	2,547
West Virginia	3,752
Total	25,016

Southwest Region Pipeline Miles	
Arkansas	6,201
Louisiana	18,569
New Mexico	6,728
Oklahoma	18,509
Texas	57,519
Gulf of Mexico	9,357
Total	116,883



Total U.S. Pipeline Mileage	301,965
Total Interstate	214,623
Total Non-Interstate	87,342

Source: U.S. Energy Information Administration.

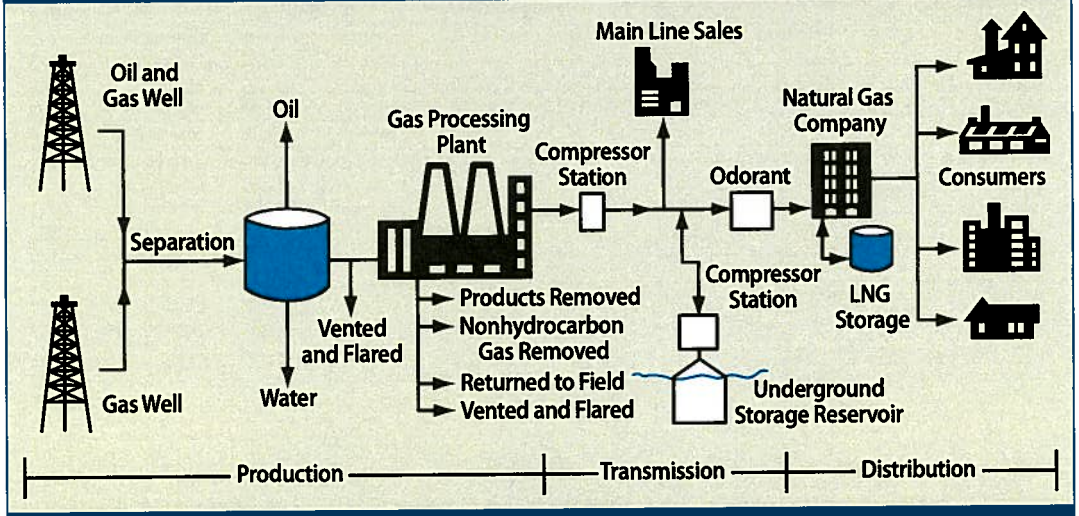
U.S., as ranked by 2005 gas production. Two other Texas fields are in the top ten — the Hugoton field stretching across the Panhandle into Oklahoma and Kansas is third, and the Carthage field in East Texas is seventh. The Giddings field in the Austin Chalk play is eighteenth.[39]

At the end of 2006, U.S. dry natural gas reserves totaled 211.1 trillion cubic feet. Federal reserves in the Gulf of Mexico were 14.5 Tcf; Texas state offshore reserves were 0.3 Tcf. Texas as a whole had 61.8 Tcf in dry natural gas reserves, a 42.1 percent increase since 2000. Texas reserves represented 29.2 percent of the total U.S. reserves.[40] To put this into perspective, total U.S. natural gas consumption in 2006 was 21.7 Tcf, down from a high of 23 Tcf in 2002.

Reserve estimates have been increasing in recent years, due primarily to the discovery of large reserves

EXHIBIT 5-11

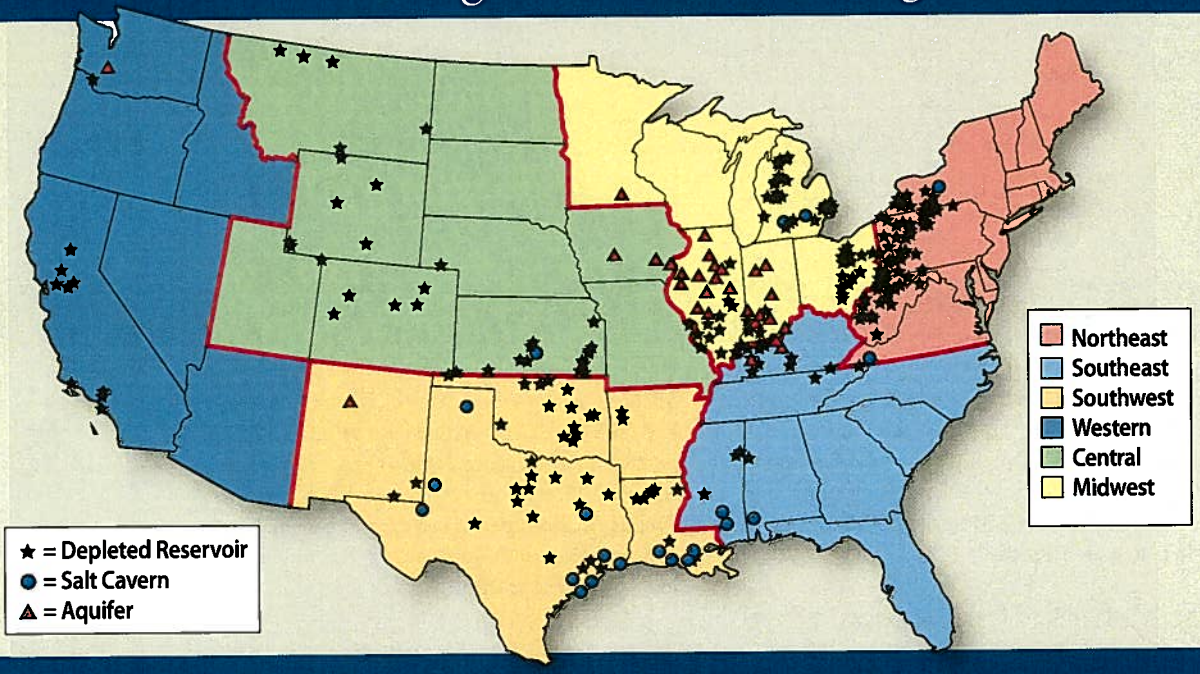
The Natural Gas Production, Transmission and Distribution System



Source: U.S. Energy Information Administration.

EXHIBIT 5-12

U.S. Natural Gas Storage Facilities as of August 2007



Source: U.S. Energy Information Administration.

of natural gas in the Gulf of Mexico. The most promising of these reserves, however, are located in areas of deep water — greater than 5,000 feet, or almost one mile — and are increasingly expensive to find and produce. (See Chapter 4 for more information on gulf exploration.)

Also, much of the U.S.'s offshore lands are off-limits to oil and gas exploration and production due to both congressional and presidential decree resulting from local environmental concerns. The American Petroleum Institute estimates that these lands could produce 656 Tcf of natural gas — more than three times existing reserves.[41]

Unconventional gas sources, though expensive to produce, are becoming more attractive and are an increasingly large percentage of total gas supply as gas prices remain near historical highs.[42] These prices, though, tend to depress consumption and therefore price.

Costs and Benefits

Natural gas is inextricably linked with crude oil in the ground and in the marketplace, even though oil is traded in a global market and natural gas is traded more often in a continental market such as that in North America. Because gas is often co-produced with oil, its price is related to the price of oil, whether that price is set on the floor of the New York Mercantile Exchange or in a boardroom of the Organization of Petroleum Exporting Countries (OPEC), and it is subject to the same political and economic pressures facing crude oil, although on a somewhat lesser scale.

Natural gas prices have been highly volatile over the last few years, due in large part to production disruptions and outages caused by hurricanes Katrina and Rita in the Gulf of Mexico. In addition, prior to these storms, cold winters on the eastern and western coasts significantly depleted the amount of natural gas held in storage, further tightening the market.

The average production cost of natural gas is computed at each individual well and is based on its type, depth, type of recovery methods used and other factors. U.S. natural gas wellhead prices were $5.80 per thousand cubic feet (Mcf) in early 2005; by October, the price had nearly doubled, to $10.33 per Mcf. During 2006, prices declined from a high of $8.02 in January to $5.09 in October. In 2007, prices began at $5.92 per Mcf in January; rose slightly in anticipation of the summer cooling season to $6.98 per Mcf in May; and fell back to $5.90 in August. By November, prices rose again to $6.37 and in January 2008, were $6.99.[43]

Environmental Impact

Natural gas is a relatively clean fuel, leaving no ash residue and producing lower emissions of nitrous oxides (NO_x), sulfur oxides (SO_x) and carbon dioxide (CO_2) than coal. In Texas in 2006, natural gas-burning electric, commercial and industrial plants emitted 42.1 percent of the state's total NO_x gases, 0.1 percent of its SO_x gases and 40.4 percent of the state's CO_2 emissions (**Exhibit 5-13**).[44]

While natural gas is a significantly cleaner-burning fuel than coal, molecule for molecule in its unburned state it is also the most potent greenhouse gas (GHG), due to its high capacity for trapping heat radiating outward from the Earth.[45]

Other Risks

In a controlled state, natural gas is very safe. If released to the atmosphere, however, it is highly combustible until it dissipates. Because of its combustibility, the greatest physical risk involved with natural gas is a sudden, uncontrolled release, either from a well, storage facility or pipeline. The most common source of these releases is an unintended piercing of a natural gas line, often by a backhoe or other construction excavation equipment.

For this reason, both the federal and Texas governments have "one-call" systems to allow anyone digging near a pipeline to make one call to a central clearinghouse, which then sends information on the proposed dig to all local utilities. These utilities can send out crews to locate and mark underground facilities.

In addition, natural gas power plants use some water. Depending on the plant type, electricity generation from natural gas requires withdrawals of between zero and 5,863 gallons per million Btu of heat energy produced. This is the amount of water extracted from a water source; most of the water withdrawn is returned to that source.

Water consumption refers to the portion of those withdrawals that is actually used and no longer

Reserve estimates have been increasing in recent years, due primarily to the discovery of large reserves of natural gas in the Gulf of Mexico.

available. Electric generation using natural gas consumes between two and 56 gallons of water for each million Btu of heat energy produced.

State and Federal Oversight

Natural gas is subject to environmental regulations similar to those placed on oil, except that natural gas does not spill (it dissipates) and thus is not subject to laws such as the Oil Pollution Act of 1990 (passed in response to the *Exxon Valdez* spill).

In Texas, the U.S. Environmental Protection Agency (EPA) has delegated most of its authority over major federal environmental laws such as the Clean Air Act, Clean Water Act, Comprehensive Environmental Response, Compensation & Liability Act (CERCLA, also known as Superfund) and the Superfund Amendments and Reauthorization Act to the Texas Commission on Environmental Quality. The major exception is oil and gas exploration and production; the Railroad Commission of Texas (RRC) has EPA-delegated authority in the oil patch.

The only other significant distinction between oil and gas environmental regulation is due to overland pipeline construction, which is much more common in the natural gas industry. Before filing a pipeline construction proposal with FERC, applicants must determine the project's need by seeking approval from the pipeline's customers and rights of way from affected landowners. Pipeline companies who receive FERC approval for a project but are unable to negotiate either passage or price successfully with affected landowners have the right under federal law to condemn privately owned land to build the project (a power also known as eminent domain). Landowners must be fairly compensated, although what constitutes "fair" can be and occasionally is disputed in state or federal court.[46] Most pipelines and other utilities work to avoid exercising eminent domain because of the potential for dispute.

EXHIBIT 5-13

Texas Electric Utility, Commercial and Industrial Air Emissions, 2006

2006	CO_2 (Metric Tons)	SO_x (Metric Tons)	NO_x (Metric Tons)
Total U.S. Emissions	2,459,800,018	9,523,561	3,799,447
Total Texas Emissions	257,552,164	558,350	260,057
Percent of U.S.	*10.5%*	*5.9%*	*6.8%*
Coal in Texas	150,589,481	523,073	119,910
Percent of state	*58.5%*	*93.7%*	*46.1%*
Percent of U.S.	*6.1%*	*5.5%*	*3.2%*
Natural Gas in Texas	104,093,526	638	109,443
Percent of state	*40.4%*	*0.1%*	*42.1%*
Percent of U.S.	*4.2%*	*0.0%*	*2.9%*
Petroleum in Texas	2,869,153	28,819	7,530
Percent of state	*1.1%*	*5.2%*	*2.9%*
Percent of U.S.	*0.1%*	*0.3%*	*0.2%*

Source: U.S. Energy Information Administration and Comptroller of Public Accounts.

Liquefied Natural Gas

An increasing share of the nation's natural gas is coming from overseas, in the form of liquefied natural gas. LNG is formed by chilling natural gas to a liquid state at minus 260 degrees Fahrenheit; it then can be loaded on specially made cargo ships and transported to a growing number of U.S. LNG ports. The liquefaction process reduces the volume of natural gas by a factor of 610, making transoceanic transportation possible. Specially equipped tankers bring LNG to the U.S. from several countries, including Trinidad and Tobago, Algeria, Egypt, Nigeria, Oman and Qatar.[47]

LNG imports became popular during the 1970s U.S. energy crises. Algeria has supplied almost all of the nation's imported LNG ever since, although in widely varying amounts. In 1973, for instance, Algeria supplied a mere 3.4 billion cubic feet (Bcf); in 1979, it shipped 252.6 Bcf; and by 1995, the total had fallen to 18 Bcf. LNG prices were competitive with domestic natural gas when domestic supplies were low; as domestic production and pipeline imports increased, however, the higher-cost LNG quickly fell out of favor with consumers. Total LNG imports settled at levels well below 100 Bcf until 1999, when imports doubled in volume from 1998 to 163 Bcf and peaked at 652 Bcf in 2004.[48] Natural gas price spikes in late 2005 after hurricanes Katrina and Rita, coupled with increasing natural gas dependence for electric generation and a deregulation of large segments of the Texas electricity generation market brought LNG back into favor.

LNG can be unloaded at just five ports in the U.S. — three along the East Coast, one on the Louisiana coast and one in federal waters in the Gulf of Mexico — where it is returned to its gaseous state ("regassed") and placed in the pipeline system. Texas has no fully operational LNG terminals at this time but FERC has approved 21 new LNG terminals, including eight in Texas, that are in varying states of construction and operation. Freeport LNG Development LP in Freeport, Texas received its first LNG shipment in April 2008.[49]

The U.S. Coast Guard, which is authorized to approve terminals in federal waters, has approved four, two in the Gulf of Mexico and two offshore from Boston. These offshore terminals are floating platforms and storage facilities located a short distance from shore, with a substantial underwater pipeline from the platform to a connecting pipeline onshore. Terminals may be located offshore for many reasons, including cost, the lack of onshore space, the location of existing pipelines at sea and local opposition to the expansion of existing facilities.

Another 14 LNG import terminals have been proposed both on and offshore the continental U.S.[50]

While LNG imports appear once again to be a promising new source of energy that may be less expensive than other natural gas supplies, Asia and Europe are major importers of LNG. That fact, coupled with Asia's and Europe's preference for long-term contracts due to their dependence on LNG, tightens world supplies, leaving little for U.S. importers to buy on the spot, or daily, market. U.S. importers tend to buy LNG at spot, rather than perhaps lower contract prices, because the U.S. depends less on LNG than other countries and uses it primarily during temporary shortages. This can inhibit the U.S.'s flexibility in negotiations with producers. In addition, the liquefaction infrastructure of many of the exporting countries is not yet capable of supplying markets on all three continents.[51]

FERC reviews the proposal and may tentatively approve the project before conducting its own thorough analysis. FERC then will issue either a draft Environmental Impact Statement (EIS) or a less complex draft Environmental Assessment (EA) for relevant federal agencies and the public to review and comment upon. At the end of the review period, and after FERC finalizes the EIS or EA, it will issues a formal "certificate of convenience and necessity," or CCN.[52]

From that point on, the applicant must obtain the necessary environmental permits prior to construction. For example, if the pipeline crosses water or wetlands, the company must obtain a permit from the U.S. Army Corps of Engineers, the federal agency responsible for protecting U.S. waters and wetlands under the Rivers and Harbors Act of 1899 and the Clean Water Act.

Other permits also may be required, depending on the proposal. Most involve environmental quality, such as permits required by the Clean Air Act, Clean Water Act, the Coastal Zone Management Act and other legislation.[53]

State historical preservation officers (SHPOs), who protect cultural and archaeological resources, also must review and comment on the proposals.[54] In Texas, the SHPO is the Texas Historical Commission.

Once the pipeline applicant receives all permits, it can construct and operate the new pipeline.

The Office of Pipeline Safety in the U.S. Department of Transportation oversees post-construction pipeline safety issues.

Intrastate Pipeline Construction

Compared to the federal process, constructing an intrastate pipeline in Texas is relatively simple. RRC, which regulates the oil and gas industry, does not require a pipeline company operating as a RRC-designated public utility to receive a formal CCN from the state.

The public utility designation is very important, as it allows companies to construct pipelines of any size under general state law, with government oversight only if problems arise. Even so, some state agencies — including the General Land Office, Texas Department of Transportation, Texas Commission on Environmental Quality or the Texas Parks and Wildlife Department — may require intrastate pipelines to receive permits from them in specific instances, such as when the pipeline crosses waterways, roads or areas out of compliance with the Clean Air Act.

These designated utilities have eminent domain authority under general state law, if right-of-way negotiations with affected landowners break down. As with their interstate counterparts, intrastate pipeline companies tend to avoid using eminent domain.

For new intrastate pipeline construction, RRC requires the operator of an intrastate transmission pipeline of one mile or more to file a report at least 30 days prior to construction with the proposed originating and terminating points for the pipeline, counties to be traversed, size and type of pipe to be used, type of service, design pressure and length of the proposed line. New construction on natural gas distribution lines, or short-distance master meter systems, is exempt from this reporting requirement.[55]

If the pipeline is longer than five miles, RRC will send inspectors to ensure the integrity of the line's welded joints. RRC jurisdiction over the pipeline is limited to safety issues.

Government Regulation and Deregulation

Government policies have had a major influence on the natural gas industry's development. Wellhead gas prices — that is, the selling price of natural gas at the point of production, the wellhead — were unregulated until the 1950s, when the U.S. Supreme Court determined that the federal government must regulate prices to prevent companies owning both the gas and the pipeline from employing unfair practices.[56] The decision, however, did not require companies to separate their production, marketing and sales and transmission functions.

For the next 20 years, the Federal Power Commission (FPC) instituted a regulatory scheme allowing all interstate sellers of natural gas, as well as producers and pipelines, to set rates based on their "cost of service," plus a regulated return on capital.

This structure affected buyers and sellers quite differently. For natural gas customers, primarily large utilities called local distribution companies, the gas they bought at their "city gate" — the pipeline terminus — came at a single "bundled" price. This meant that the cost of gas, transportation and service guarantees were rolled up into one regulated price. Customers, for the most part, were unable to choose among gas suppliers or services.

For producers, a regulated pricing structure was enough of a disincentive to interstate commerce to spur natural gas shortages in the 1970s. But because the law did not restrict *intrastate* sales of natural gas, Texas saw half of its natural gas production dedicated to the home-state market, exacerbating shortages elsewhere.

The 1973 Arab oil embargo heightened Congress' fear of low oil and gas supplies, so it passed the Powerplant and Industrial Fuel Use Act of 1978, which discouraged the use of natural gas in favor of coal and renewable fuels, further depressing interstate natural gas prices and supplies. Relief came with the passage of the Natural Gas Policy Act of 1978 (NGPA), which relaxed — but did not remove — federal wellhead price controls. Congress intended the NGPA to create a national natural gas market, equalize supply and demand and allow market forces to determine wellhead prices.[57]

Now able to sell interstate natural gas at higher prices, Texas producers benefited substantially. Drilling and natural gas production increased, and the interstate pipeline system grew more robust. Competition for supplies increased and, combined with natural gas buyers' memory of

shortages, provided enough motivation for buyers to negotiate high-cost, multi-year contracts for natural gas supplies. Predictably, consumer protests of high energy prices soon followed.

FERC, born of the same post-Oil Embargo era, was created as an independent agency to replace the FPC. FERC's mission was to regulate interstate natural gas, electricity and hydropower transmission and costs.

From the mid-1980s through the mid-1990s, FERC issued a series of orders gradually deregulating pipelines, first by allowing and then by requiring companies to create separate business units to buy, sell and transport gas.[58] As the companies separated into different units, rates were "unbundled," allowing customers to select from a menu of services offered by a now wide variety of businesses. These services could include guarantees from either the supplier or the pipeline, or both, that the customer would receive full supplies in times of shortage; paying a new middleman known as a "gatherer" to find and package natural gas supplies for shipment; or paying for and using gas held in storage.

These orders fundamentally altered the industry by introducing competition. The previously regulated and monopolistic pipeline system became exponentially more complex with deregulation.

For gas buyers, the point of sale moved from the city gate to the wellhead. Pipelines were no longer exclusive to particular companies or customers; they became "open access" transporters, much like interstate highways. Customers now could choose what gas they would buy; the suppliers from whom they would buy it; the services they required; and how and when gas would be delivered to them.

Subsidies and Taxes

Chapter 3 of this report discusses major taxes related to the oil and gas industries, including severance taxes, which accounted for a little more than 9 percent of state tax revenue in 2006. Chapter 28 contains information on subsidies for the oil and gas industries.

Other States and Countries

As discussed above, unconventional sources of natural gas are being developed in many parts of the country, while producers are unable to access many promising federal offshore areas because of congressional and presidential orders.

LNG is once again emerging as a promising method to transport fuel to the U.S. from overseas. However, the U.S. is in competition for supplies with Asian and European countries that are growing dependent on LNG, while LNG-producing countries have limited export capabilities. Substantial investment in LNG production infrastructure will be required to increase LNG production significantly and balance the market.

Outlook for Texas

The largest issue involving natural gas is supply. Supply pressures are being mitigated by continual innovation in the types of deposits pursued and growing LNG terminal capacity.

Natural gas production depends on pressure in the formation; with every cubic foot removed, the pressure is reduced. As a consequence, natural gas fields tend to become depleted quickly. Throughout the history of the industry in Texas, many fields have produced substantial amounts of gas for a short period and then lost pressure. Texas producers now pursue unconventional gas plays throughout the onshore part of the state, fracturing rock formations with sand-bearing liquids to expand the gas-producing areas underground. Horizontal drilling also can increase natural gas production in certain areas.

U.S. demand for natural gas is projected to grow by 0.5 percent annually through 2030. In view of declining domestic production, imports of natural gas will become increasingly important. LNG imports are expected to account for about 25 percent of the nation's supply of natural gas by 2030.[59]

Natural gas is a proven, reliable and relatively clean and inexpensive energy source. Texas is a major producer and consumer, but without continued strong gas prices and continuing advancements in technology, natural gas producers may find it more difficult to keep producing adequate supplies. And natural gas prices are partly dependent on international oil prices, presenting another major challenge to U.S. energy independence.

LNG imports are expected to account for about 25 percent of the nation's supply of natural gas by 2030.

EIA expects oil and natural gas production to continue declining for the foreseeable future, but industry employment and wages should continue to remain steady or increase slightly through 2035.[60]

In the meantime, new technology will allow us to produce from ever-deeper and more unconventional reserves. LNG imports are all but certain to become more important to the national energy portfolio, and new terminals under construction in Texas will increase employment and pipeline usage.

For the foreseeable future, natural gas will continue to serve Texas well both as fuel and as an important industry. Increasing concerns about either carbon dioxide emissions or the importation of natural gas from countries that may prove to give U.S. leaders foreign policy headaches could limit natural gas' growth as a fuel. Given natural gas' benefits, however, it should remain important throughout the century.

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