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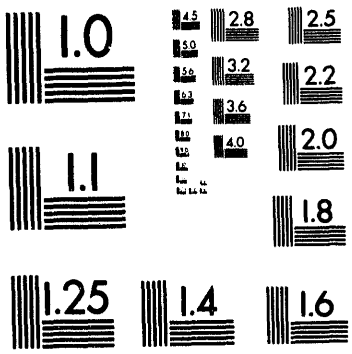

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Energy Information Sheets

December 1993

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Preface

The National Energy Information Center (NEIC), as part of its mission, provides energy information and referral assistance to Federal, State, and local governments, the academic community, business and industrial organizations, and the general public. Written for the general public, the EIA publication *Energy Information Sheets* was developed to provide information on various aspects of fuel production, prices, consumption and capability. The information contained herein pertains to energy data as of December 1991. Additional information on related subject matter can be found in other EIA publications as referenced at the end of each sheet.

Questions concerning the contents of this publication can be addressed by the National Energy Information Center. Questions concerning the publication itself should be addressed to Karen Freedman at (202) 586-9254. The *Energy Information Sheets* is published annually, with each issue superseding the previous issue. The publication is free and can be obtained from NEIC at the following address:

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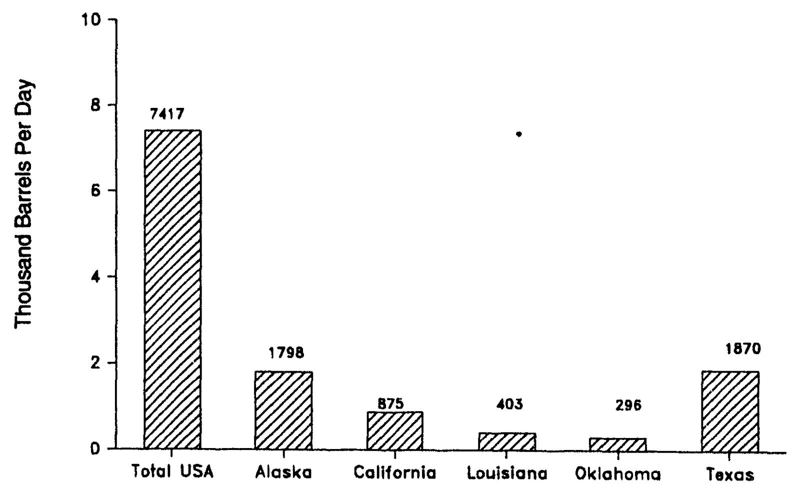
Crude Oil Production

Crude oil is a product of the decayed remains of prehistoric marine animals and plants. Over centuries, organic matter and mud were subjected to extreme heat and pressures. As additional layers accumulated, the heat and pressure caused crude oil-saturated rock to form.

Crude oil is a malodorous yellow-to-black liquid usually found in underground reservoirs. Drilling a well to extract crude oil is a complicated process, but it is the only known way to confirm the existence of the oil. After initial exploration activities, site preparation begins. The type of rig system to be used, whether rotary or cable, is determined and erected. Then, a derrick, the tall structure above the hole which houses tools and pipes that go into the well, is constructed. When completed, the drilled well will be turned into a production facility capable of bringing a steady flow of oil to the surface.

In 1991, total domestic crude oil field production averaged 7,417,000 barrels per day, an increase of 62,000 barrels per day from the 1990 average. The top crude oil-producing States are Texas, Alaska, California, Louisiana, and Oklahoma.

U.S. Crude Oil Production, 1991



Source: Energy Information Administration, *Petroleum Supply Annual*, 1991, Volume 1, DOE/EIA-0340(91)/1.

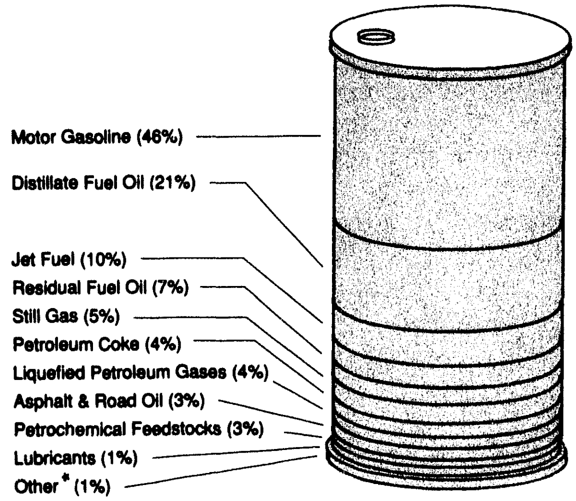
Because the uses for crude oil in its natural state are limited, almost all crude is processed into finished petroleum products at a refinery. This refining process usually involves (1) *distillation*, or separation of the hydrocarbons that make up crude oil so that the heavier products, such as asphalt, are separated from some of the lighter products, like kerosene; (2) *conversion*, or cracking of the molecules to allow the refiner to squeeze a higher percentage of light products, such as gasoline, from each barrel of oil; and (3) *treatment*, or enhancement of the quality of the product which could entail removing sulfur from such fuels as kerosene, gasoline, and heating oils. The addition of blending components to gasolines is also a part of this process.

While getting the oil out of the ground may seem complicated, moving it from the point of production to the final consumer is just as complex. Today there are more than 200,000 miles of pipeline in the United States.

Crude oil is measured in barrels. In 1991, one barrel of crude oil when refined typically yielded the following petroleum products in gallons:

Product	Gallons
Finished Motor Gasoline	19.19
Distillate Fuel Oil	8.95
Kero-Type Jet Fuel	3.82
Residual Fuel Oil	2.81
Still Gas	1.97
Petroleum Coke	1.72
Liquefied Petroleum Gas (LPG)	1.68
Asphalt and Road Oil	1.30
Petrochemical Feedstocks	1.22
Naphtha-Type Jet Fuel	0.50
Lubricants	0.46
Miscellaneous Products	0.29
Special Naphthas	0.67
Kerosene	0.13
Finished Aviation Gasoline	0.08
Waxes	0.04
Total	44.83

Product Yield from a Barrel of Crude Oil, 1991



* Includes kerosene, special naphthas, aviation gasoline, waxes, and miscellaneous products.

A 42-U.S. gallon barrel of crude oil yields slightly more than 44 gallons of petroleum products. This "process gain" is due to a reduction in the density of the crude oil during the refining process. The result is an increase in volume.

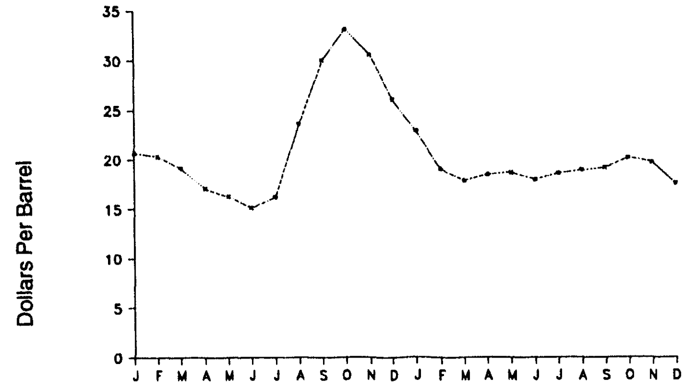
The United States and the former Soviet Union, along with the Organization of Petroleum Exporting Countries (OPEC), accounted for 68 percent of the total crude oil produced in the world in 1991. The United States produced 12 percent of the world's total 1991 production, and the former Soviet Union produced 16 percent.

More information on this subject can be found in the following Energy Information Administration publications: *Monthly Energy Review, Annual Energy Review, Petroleum Supply Monthly, Petroleum Supply Annual,* and *Petroleum: An Energy Profile.*

Crude Oil and Petroleum Product Prices

Crude oil is processed at a refinery where it is transformed into useable petroleum products. The average cost of crude oil to U.S. refiners (referred to as the "composite refiner acquisition cost") greatly affects the final cost of petroleum products. The composite refiner acquisition cost peaked in 1981 at $35.24 per barrel, then declined in 1986, remaining below $20 through 1989. However, two dramatic energy-related events of 1990 and 1991 caused a slight fluctuation in crude oil prices: the war in the Persian Gulf, which entailed the loss of Iraqi and Kuwaiti oil, and the dissolution of the U.S.S.R, the world's leading oil producer. In 1990, as a result of the Persian Gulf Crisis, the average cost rose to $22.22 per barrel but dropped to $19.06 in 1991.

Composite Refiner Acquisition Cost of Crude Oil, 1990-1991



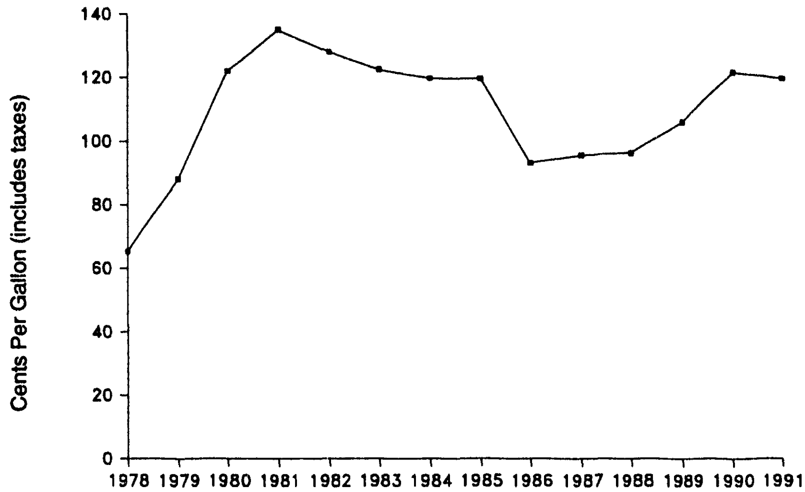
Source: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035.

Motor gasoline constitutes about half of the total volume of products produced from crude oil. Retail gasoline prices generally follow the same pattern as crude oil prices; however, prices fluctuate widely based on supply and demand conditions. Data from the Energy Information Administration (EIA) indicate that taxes and factors other than the cost of crude oil account for more than half of the price paid by the consumer for a gallon of gasoline.

Environmental concerns have played a key role in changing the formulation of motor gasoline. The phaseout of lead in motor gasoline was brought about by a series of 1970's initiatives aimed at reducing emissions. By 1990, leaded motor gasoline represented only 5 percent of total gasoline sales and had been replaced almost entirely by unleaded. Refining processes have been changing in order to produce high octane motor gasoline in the absence of lead, and in response to tighter restrictions on motor gasoline volatility (RVP), which became effective in 1989. Ethers such as methyl tertiary butyl ether (MTBE), and alcohols such as ethanol, have become important additives for boosting the octane of motor gasoline. New specifications for oxygenated and reformulated gasoline set forth in the Clean Air Act Amendments of 1990 will make these additives increasingly important in the future.

No. 2 distillate includes No. 2 fuel oil and No. 2 diesel fuel. Currently these products are physically similar; however, distillate fuel that is intended for use in passenger cars (No. 2 diesel fuel) is blended with kerosene to increase its liquidity during cold weather. The cost of this process, in addition to Federal, State, and local motor fuel taxes, partially explains why No. 2 diesel fuel prices are higher than those for No. 2 fuel oil. By 1993 more product differentiation will be evident as recent legislation has mandated limits on sulfur content for on-highway diesel which do not exist for fuel oil.

Motor Gasoline Prices at the Pump (All Types), 1978-1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

The price data available for No. 2 diesel fuel are for sales through company-operated retail outlets and do not include taxes. The average U.S. sales price of No. 2 fuel oil sold to residential consumers for heating, 119.4 cents per gallon in 1981, declined to 80.3 cents per gallon in 1987, and rebounded to 106.3 cents per gallon in 1990, then declined to 101.9 cents per gallon in 1991. In 1983, the price of No. 2 diesel fuel averaged 94.3 cents per gallon, dropping to 88.6 cents per gallon in 1985 and to 59.8 cents per gallon in 1986. In 1990, the price had risen to 85.2 cents per gallon, dropping to 74.5 cents per gallon in 1991. The sales price of No. 2 diesel through company-operated outlets has been consistently lower than No. 2 fuel oil prices but, when taxes are added, diesel is more expensive to the consumer.

Residual fuel oil is the heavy, viscous oil that remains after the other fractions have been distilled off in the refining process. It is used for generating electricity, for space heating, for industrial purposes and as fuel for ships. The average refiner's price of residual fuel oil to end-users peaked at 75.6 cents per gallon in 1981, then fell to 34.3 cents per gallon by 1986 and slid further to 33.4 cents per gallon in 1988. The average price rebounded to 44.4 cents per gallon in 1990, but dropped substantially to 34.0 cents per gallon in 1991.

In the late 1970's, prices of most petroleum products were subjected to Federal Government price control regulations. On January 28, 1981, all remaining product and crude oil prices were decontrolled, establishing a free market for petroleum pricing. Refiner, distributor, and retailer pricing decisions for petroleum products are now based on the operation of a free market economy and may, therefore, differ not only from region to region, but from State to State, and even from one area to another in the same State.

More information on these subjects may be found in the EIA publications: *Monthly Energy Review, Annual Energy Review, Petroleum Marketing Monthly, Petroleum Marketing Annual,* and *Weekly Petroleum Status Report.*

Petroleum Products Consumption

Did you know that approximately 3,000 products are made from an oily substance known as petroleum? Ink, crayons, bubble gum, dishwashing liquids, deodorant, eyeglasses, records, tires, ammonia, and heart valves are just a few examples.

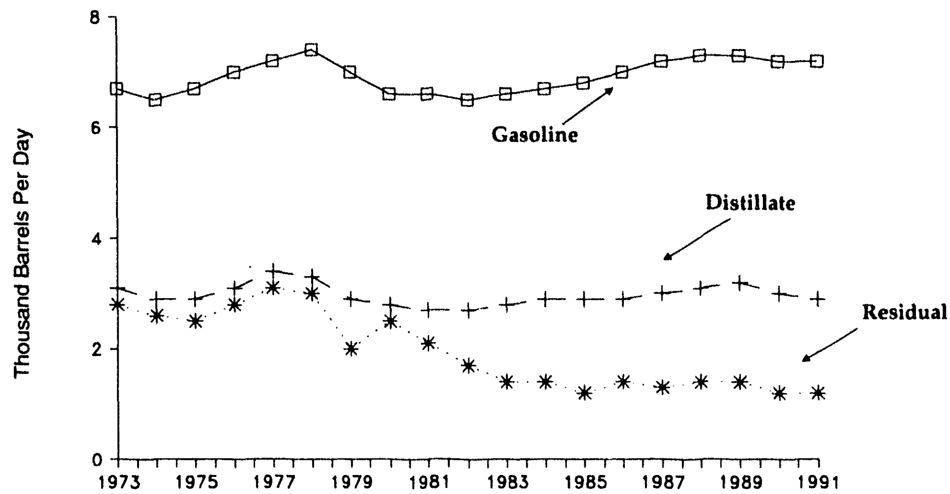
When crude oil was first discovered in the United States, it was taken from natural pools on the earth's surface and was used mainly for medicinal purposes. These natural pools supplied about 3 gallons of oil a day (per pool). As the population expanded and the need for the oil grew, and as whale oil, an alternative to crude oil, became scarce as a source for lighting, the need to produce more crude oil was addressed.

In Titusville, Pennsylvania, using the same technology as they used to drill for water, producers excavated the first successful oil well in 1859. As crude oil became ample, refineries sprang up to process it into useable petroleum products. The main product was kerosene, which began replacing whale oil as the prime source of illumination. Other main petroleum products refined out of a typical 42-U.S. gallon barrel (industry standard) were greases and lubricants. Today, there are many refined products, the major ones being motor gasoline, distillate fuel oil, and kerosene jet fuel. These major petroleum products heat homes and businesses and supply power to automobiles, transportation systems, and other industries.

In 1991, the effects of the recession and unusually warm winter weather led to the lowest level of domestic petroleum consumption since 1987, 16.7 million barrels per day. In 1990, total U.S. demand for petroleum was 17.0 million barrels per day, of which 7.2 million barrels per day, or 42 percent, was from net imports (imports minus exports), the highest import dependency level since 1979. Imports nearly doubled between 1970 and 1973, the year of the Arab oil embargo, rising to nearly 6.3 million barrels per day, with crude oil accounting for more than half. Net imports averaged more than 6 million barrels per day. The Organization of Petroleum Exporting Countries (OPEC) sources supplied almost 3 million barrels per day (net) of crude oil and products in 1973, or approximately 17 percent of total U.S. demand. The growth in imports was due largely to nationwide economic growth, rising personal income, and greater numbers of automobiles which stimulated demand for oil, just as domestic crude oil production, which had peaked at 9.6 million barrels per day in 1970, began to decline. In 1978, the year of peak demand, the average demand was 18.8 million barrels per day, of which 42.5 percent, or 8 million barrels per day, was from net imports.

Motor gasoline is the petroleum industry's principal refined product. In the peak year, 1978, the average daily consumption was 7.4 million barrels. In 1991, the average daily consumption was 7.2 million barrels, a 3-percent decrease from the 1978 high.

Petroleum Products Consumption in the United States, 1973-1991



Source: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035.

Distillate fuel oil consists of diesel fuels and fuel oils. Diesel fuels furnish power to diesel engines, such as those used in heavy construction equipment, trucks, buses, tractors, trains, and some automobiles. No. 2 fuel oil is utilized in the central heating of homes and small buildings. Distillate fuel oil consumption for 1991 was 2.9 million barrels per day, a 15-percent decrease from the 1978 high of 3.4 million barrels per day.

Residual fuel oil is heavier than distillate fuel oil; i.e., it has a higher density, viscosity, and boiling point. It is used mainly by electric utilities, large apartment and commercial buildings, and industries that maintain kilns, open-hearth furnaces, and steam boilers. Residual fuel use has declined since 1977, reaching a consumption level in 1991 of 1.2 million barrels per day, a 62-percent decrease from the 1977 high of 3.1 million barrels per day. Conservation efforts and fuel-switching are the two main reasons cited for the drop in consumption.

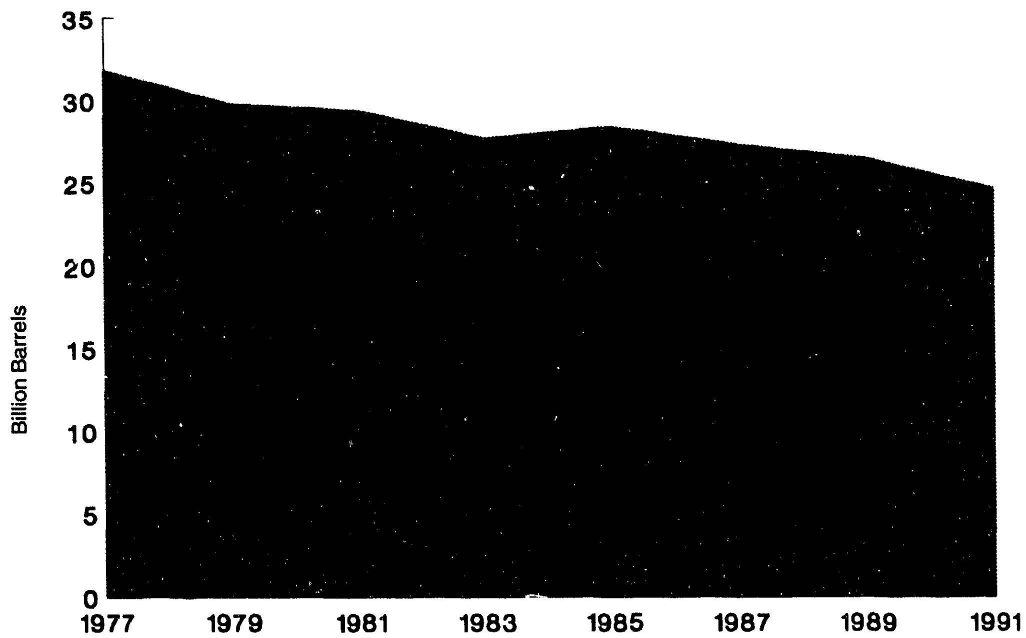
Since 1973, the year of the oil embargo, the three Organization for Economic Cooperation and Development countries that have consistently consumed the most petroleum products are the United States, Japan, and West Germany. During 1991, for example, the United States consumed 16.7 million barrels per day; Japan consumed 5.3 million barrels per day; and the unified Germany consumed 2.8 million barrels per day.

More information on this subject may be found in the EIA publications: *Monthly Energy Review*, *Energy Facts*, and *Petroleum: An Energy Profile.*

Petroleum Reserves

Proved reserves of crude oil are the estimated quantities that geological and engineering data demonstrate, with reasonable certainty, can be recovered in future years from known reservoirs, assuming existing economic and operating conditions. Proved reserves make up the domestic production base and are the primary source of oil and gas used in the United States. Total proved reserves of crude oil in the United States, as of year-end 1991 (the latest year for which data are available), are 24.7 billion barrels, a 6-percent decrease from that of 1990 and the largest annual decline since 1977. Thirty-one States have crude oil reserves. The top five are Texas, with 6.8 billion barrels; Alaska, with 6.1 billion barrels; California, with 4.2 billion barrels; Wyoming, with 757 million barrels; and New Mexico, with 721 million barrels. In addition, there are substantial crude oil reserves in the Federal Offshore fields: 1.8 billion barrels in the Gulf of Mexico and 785 million barrels in the Pacific.

U.S. Crude Oil Proved Reserves, 1977-1991



Source: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, 1977 through 1991 annual reports, DOE/EIA-0216.

Estimates of proved crude oil reserves **do not** include the following: (1) "indicated additional reserves," a category of oil that is reported separately and may become available from known reservoirs through the application of improved recovery techniques using current technology; (2) natural gas liquids (including lease condensate); (3) oil of doubtful recovery because of uncertainty as to geology, reservoir characteristics, or economic factors; (4) oil that may occur in undrilled prospects; and (5) oil that may be recovered from oil shales, coal, gilsonite (asphalt), and other such sources.

Volumes of crude oil placed in underground storage, such as those in the Strategic Petroleum Reserve, are not considered proved reserves. The Strategic Petroleum Reserve was created to diminish the impact of disruptions in petroleum supplies and to carry out obligations of the United States under the International Energy Program. In 1975, Public Law 94-163 (the Energy Policy and Conservation Act) established the Strategic Petroleum Reserve of up to 1 billion barrels of petroleum supplies. These petroleum stocks are to be maintained by the Federal Government for use during periods of major supply interruptions. At the end of December 1991, there were 569 million barrels of crude oil in the Reserve.

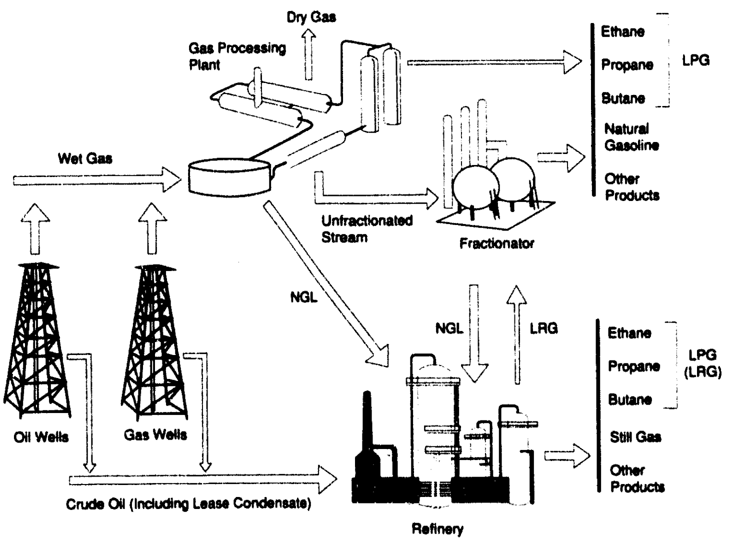
More information on this subject may be found in the EIA publications: *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves Annual Report* and *Annual Energy Review.*

Propane

Propane, also known as "bottled gas," is a colorless paraffinic hydrocarbon. As a liquefied petroleum gas (LPG), it is classified along with ethane, butane, ethylene, butylene, and propylene.

With a chemical formula of C_3H_8 and a molecular weight of 44.094, propane occurs in both liquid and gaseous forms. At normal temperature and atmospheric pressure, it is a gas, while slight changes in pressure or temperature cause it to become a liquid. Although it is actually nontoxic and odorless, a foul-smelling sulfur-containing compound known as ethyl mercaptan is added to propane so that leaks can be easily detected.

Propane along with other LPG's can be produced at either petroleum refineries or at natural gas processing plants. After production, propane is then shipped from the refineries and processing plants to distribution terminals and underground storage facilities by pipeline and from there can be carried by truck, rail, barge or tanker.



Source: Energy Information Administration, Office of Oil and Gas

Propane is normally stored and transported in its compressed liquid form, and is often supplied in portable steel cylinders or tanks. By opening a valve to reduce pressure in the storage container, the liquid is vaporized into a gas for use.

Of the 90.5 million households in the United States, 7.7 million depend on propane for one use or another. The following is an outline of propane use in the major sectors of the United States:

Residential: Propane use by homeowners has mainly been for space heating, clothes drying, and recreational outdoor cooking. Additionally, it is the principal heating fuel for mobile homes, as well as in rural areas of the United States where natural gas service is not available.

Commercial: Restaurants and caterers use propane for cooking and warming food, while warehouse owners have long chosen it to fuel forklifts.

Agricultural: Farmers have found propane useful to dry crops, warm greenhouses and chicken coops, burn weeds, and sterilize milking equipment.

Transportation: Owners of fleets of vehicles have found clean burning propane to be an alternative fuel for use in internal combustion engines. Propane is high in octane and releases negligible amounts of emissions. When burned, propane leaves no ash and produces practically no sulfur oxides since its combustion products (carbon dioxide and water vapor) are easily absorbed into the atmosphere. For this reason, it is often used in vehicles which are run indoors or in mines.

Industrial: Vulcanizing of rubber and metal cutting are some of the industrial uses.

Utilities: Propane is frequently used as a back-up fuel during peak generating periods or peakshaving periods by electric utilities. Natural gas utilities use a propane-air mixture as a supplemental fuel during periods of peak demand.

Chemical: Propane has a significant part in the manufacture of petrochemical feedstock, aerosol propellants, solvents, and synthetic rubber.

Almost 90 percent of the U.S. supply of propane is derived from domestic production. Of the total, nearly half is produced at approximately 675 natural gas processing plants, and about 41 percent is produced at 135 petroleum refineries nationwide. The remaining 10 percent comes from foreign sources. Import levels for 1991 totaled 33.3 million barrels while U.S. exports of propane were 10.1 million barrels. (A barrel contains 42 U.S. gallons.)

By December 1991, nationwide primary stocks -- stocks held at refineries, bulk terminals, gas processing plants, and pipelines -- were at 46.9 million barrels, a level that was slightly above the average adequate supply range for that time of year. During the warmer months, however, inventories can be as high as 51.6 million barrels -- as seen in August 1991 -- while the demands of the winter heating season bring a drawdown of propane stocks.

When propane stocks are low, propane prices tend to rise. Such a typical supply/demand relationship was evidenced by 1991's refiner retail propane prices which, excluding taxes, began the year at almost 90 cents per gallon, hovered around 60 cents in the summer, and then rose to over 70 cents a gallon by December.

More information on this subject may be found in the EIA publications: *Winter Fuels Report, Petroleum Supply Monthly, Petroleum Supply Annual, Petroleum Marketing Monthly, Petroleum Marketing Annual,* and *Petroleum: An Energy Profile*

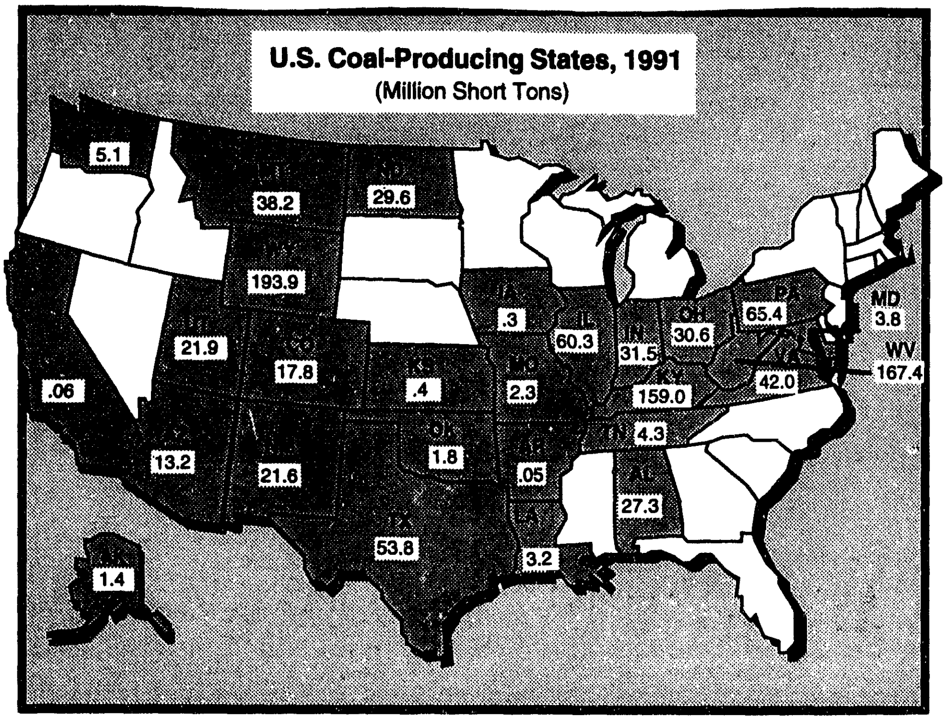
Coal Production

Coal, a fossil fuel like petroleum and natural gas, is a sedimentary organic rock that contains more than 50 percent carbonaceous material by weight. It is composed largely of carbon, hydrogen, oxygen, nitrogen, and sulfur, with smaller amounts of other materials ranging from aluminum to zirconium.

Coal had its beginning as ancient plants that grew in swamps millions of years ago. Geological processes working over vast spans of time compressed and altered the plant remains, increasing the percentage of carbon present, thereby producing the different ranks of coal: lignite, subbituminous, bituminous, and anthracite.

In the United States, lignite is mined chiefly in Texas, North Dakota, and Louisiana; and subbituminous coal is mined principally in Wyoming. Bituminous coal is mined mostly in the Appalachian and Interior Regions, while anthracite, the highest ranking coal, is mined only in northeastern Pennsylvania. About two-thirds of the coal produced in the Nation is bituminous coal.

Coal production in 1991 was 996 million short tons, down 33 million short tons from the record level in 1990. This decrease was attributed to slower stock buildup at the electric utilities and a decline in demand for coal at coke plants. Most of the coal produced was for electric power plants. The average mine price of coal fell for the ninth consecutive year to $21.49 per short ton.



Source: Energy Information Administration, *Coal Production Annual*, 1991, DOE/EIA-0118(91).

In 1991, Wyoming was the Nation's leading coal-producing State for the fourth consecutive year. Wyoming's coal production was 194 million short tons, which was about 20 percent of the national total. West Virginia ranked second, with 167 million short tons (17 percent), and Kentucky was third, with 159 million short tons (16 percent). Together, these three States accounted for 52 percent of total U.S. coal production.

There were 210 mines in 1991 that produced 1 million or more short tons. They produced 66 percent of the total national production, although they represented only 7 percent of active mines. The Nation's largest coal mine, located in Campbell County, Wyoming, continued to be the Black Thunder Mine, with nearly 31 million short tons produced. Of the 210 large mines, 143 mines east of the Mississippi River produced about 273 million short tons, and 67 mines to the west produced 386 million short tons. Although the amount of coal produced in the United States has increased, the average heat content of the coal has declined because of a larger output of low-rank coal.

Productivity in 1991 set a fifth consecutive annual record, reaching 4.09 short tons per miner per hour. The average number of miners working daily fell slightly to 120,602.

Federal and Indian lands have become increasingly important sources of coal. The 268 millicn short tons produced from these lands in 1991 accounted for about 27 percent of the total U.S. coal output. Federal coal lands produced 240 million short tons in 10 States, and Indian coal lands yielded 27 million short tons in 3 States.

World coal production increased from 4.3 billion short tons in 1982 to 5.1 billion short tons in 1991. The major producers were: China, the United States, and the former Soviet Union. These three leading producers accounted for about 58 percent of the total 5.1 billion short tons produced in 1991.

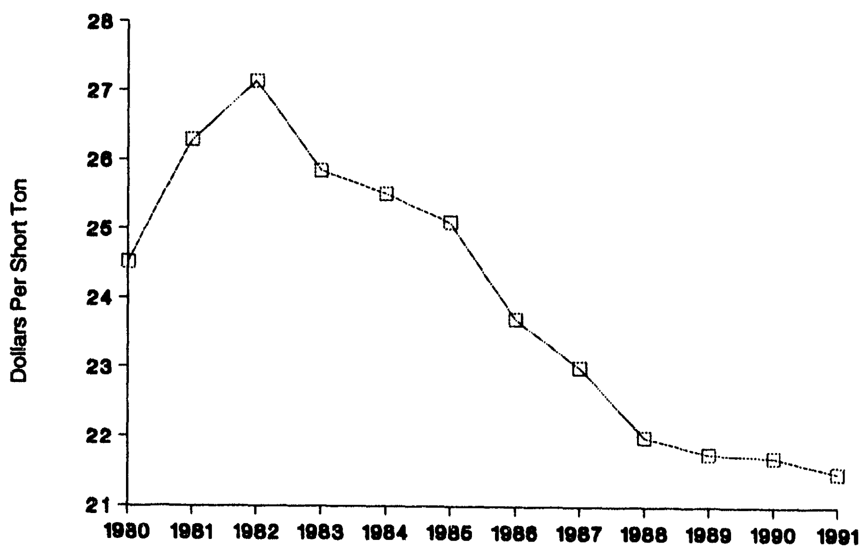
More information on this subject may be found in the Energy Information Administration publications: *Annual Energy Review*; *Weekly Coal Production*; *Coal Production Annual*; *Coal Data: A Reference*; *Monthly Energy Review*; and *International Energy Annual*.

Coal Prices

In the early 1900's, coal was the Nation's major fuel source, supplying almost 90 percent of its energy needs. Later, coal's importance declined, mainly because petroleum and natural gas were cost effective and efficient. However, at the present time, coal is the primary source used for electricity generation because it is now far cheaper than other fossil fuels and is also more abundant in the United States. About three-fourths of the coal produced in the United States in 1991 was delivered to domestic power plants. Of the total coal consumed in the United States, 87 percent was used for generating electricity -- accounting for about 55 percent of the total electricity produced.

During the early 1970's, natural gas was the least expensive fuel used to generate electricity. In 1973 (the first year in which such data were recorded), electric utilities paid, on the average, about 34 cents per million Btu of natural gas, 41 cents per million Btu of coal, and 79 cents per million Btu of petroleum. Since 1976, however, coal has been the least expensive fossil fuel used to generate electricity. In 1976, electric utilities paid about 85 cents per million Btu of coal. In 1991, electric utilities paid about $1.45 per million Btu of coal, about two-thirds the cost for natural gas ($2.15 per million Btu) and a little more than half that paid for petroleum ($2.55 per million Btu.) Although these figures show that the cost of generating electricity from coal has increased significantly, it is still lower than the cost of generating electricity from either natural gas or petroleum.

Average Mine Price of U.S. Coal, 1980-1991



Source: Energy Information Administration, *Coal Production Annual*, 1980 through 1991 annual reports, DOE/EIA-0118.

The average mine price per short ton of coal in 1991 was $21.49. Because coal is so abundant, and as long as it remains relatively low priced, power plants will continue to use it rather than the two other major fossil fuels -- petroleum and natural gas -- to generate electricity.

Another important use of coal is to produce coke, which is used in smelting iron ore to make steel. The average price paid for the special type of coal used to make coke generally declined in the early 1980's, although from 1990 to 1991 it increased slightly from $47.79 to $48.88 per short ton.

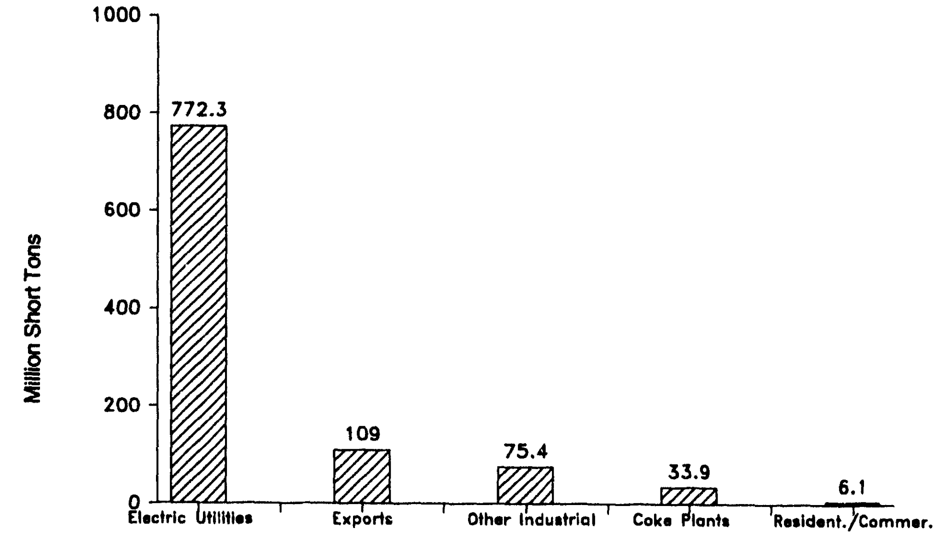
U.S. coal exports rose to 109 million short tons in 1991 from 106 million short tons in 1990, and the average price was $42.39. U.S. coal imports totalled more than 3 million short tons in 1991, a little more than in 1990, and the average price was $33.12 per short ton.

More information on this subject may be found in EIA publications: *Cost and Quality of Fuels for Electric Utility Plants, Electric Power Monthly, Electric Power Annual, Quarterly Coal Report, Monthly Energy Review,* and *Coal Data: A Reference.*

Coal Demand

During 1991, a total of 887.6 million short tons of coal was consumed in the United States. The greatest demand for coal was by electricity generating plants that burn coal to produce electricity. In 1991, 772.3 million short tons were used by electric utilities, accounting for 87 percent of coal consumed in the United States. Over 55 percent of the electricity generated was by coal-fired plants. Each ton of coal consumed at an electric power plant produces about 2,000 kilowatt hours of electricity. A pound of coal supplies enough electricity to light ten 100-watt bulbs for about an hour.

U.S. Coal Demand by Sector, 1991



Source: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035.

In November 1990, the Clean Air Act Amendments of 1990 were signed into law and will affect the quality of coal used by electric utilities. The goal of Title IV (Acid Deposition Control) of the new Clean Air Act is a 10-million-ton reduction in sulfur dioxide (SO_2) emissions from 1980 levels. Annual allowances, each permitting the emission of one ton of SO_2, will be allocated by the Environmental Protection Agency (EPA), based on unit size, primary fuel, on-line year, 1985 emissions rate, and past energy use. Additionally, EPA will set emissions limits for nitrogen oxides.

The United States was second after Australia as one of the world's leading exporters of coal. Coal exports in 1991 were 109 million short tons, or about 11 percent of demand. The primary destination countries of U.S. exports were Canada, Japan, and Italy.

The third largest sector of coal demand was for industrial use. Industrial use of coal amounted to 75.4 million short tons in 1991. Some industries that used coal included: cement, chemicals, paper, and primary metals. Cement plants use about a ton of coal for each 3.5 tons of cement produced. Small amounts of coal are also used to manufacture a number of everyday products such as: photographic film base, carbon and graphite electrodes, varnishes, perfumes, dyes, plastics, paints, and inks.

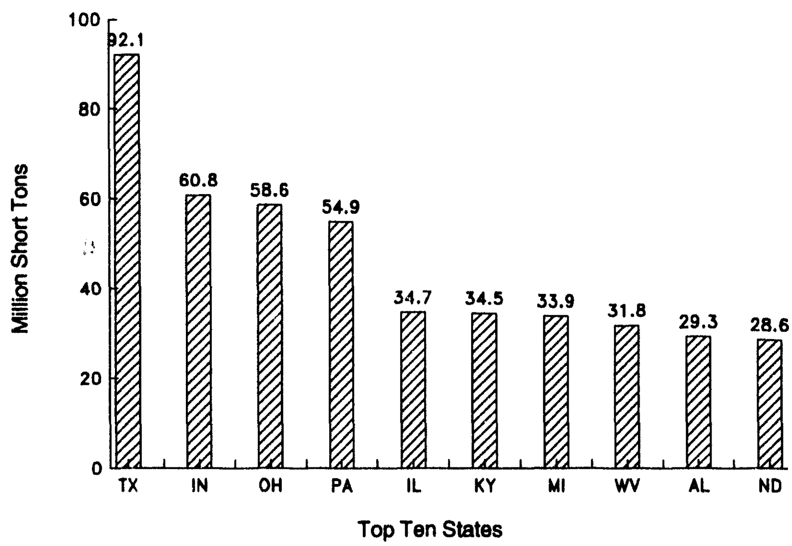
In 1991, 33.9 million short tons were consumed by coke plants. Through a process known as "carbonization," coal is converted into coke. Coke is then used in smelting iron ore to produce steel. Both the number of coke plants and the amount of coal carbonized have declined since 1973. There are presently about half as many coke plants as there were a decade ago.

The residential and commercial sectors consumed a small percentage of coal for building heating, using 6.1 million short tons in 1991.

Over 528 million short tons of coal transported within the United States was moved by rail. River barge shipping in the inland waterways system was the next most prevalent mode, carrying over 134 million short tons. Slightly more than the amount of coal shipped by truck, was carried by tramway, conveyors, and coal slurry pipeline. The Nation's only coal slurry pipeline, the 273-mile-long Black Mesa line, carried over 4 million short tons of coal in 1990. The slurry is composed of half water and half finely ground coal and delivers coal from a mine in Arizona to a power plant in southern Nevada.

Texas led all States in coal consumption in 1991, using over 90 million short tons. Indiana and Ohio were second and third, respectively. These three States accounted for almost a quarter of the total U.S. coal consumption for the year. Ranked tenth in coal use, North Dakota is the site of one of three operating coal gasification plants in the United States. These plants use coal to produce natural gas. The Dakota Gasification Company uses 16,000 short tons of lignite per day to produce about 142 million cubic feet per day of synthetic natural gas. The other two operating gasification plants are in Louisiana and Tennessee.

U.S. Coal Demand by State, 1991



Source: Energy Information Administration, *Quarterly Coal Report*, October-December 1991, DOE/EIA-0121(91/4Q).

More information on this subject may be found in the EIA publications: *Quarterly Coal Report*; *Coal Distribution*; *Monthly Energy Review*; *Coal Data: A Reference*; and *Energy Facts*.

Coal Reserves

The United States contains vast deposits of coal -- more extensive than those of natural gas and petroleum, the other major fossil fuels. If total estimated recoverable energy reserves of the major fossil fuels are compared on the basis of heat content, about 3 percent of reserves are crude oil, about 4 percent are natural gas, and over 90 percent are coal.

Total U.S. coal resources in the ground are estimated to be 4.0 trillion tons, of which 1.7 trillion tons are identified resources. Identified resources include the demonstrated reserve base, which comprises coal resources that have been mapped within specified levels of reliabilitiy and accuracy and which occur in coalbeds meeting minimum criteria of thickness and of depth from the surface generally required for economic mining under current technologies. As of January 1, 1992, the U.S. demonstrated reserve base contains an estimated 476 billion short tons. Because of property rights, land use conflicts, and physical and environmental restrictions, some coal in the demonstrated reserve base may not be available and accessible for mining.

The actual proportion of minable coal resources that can be recovered from undisturbed deposits varies from less than 40 percent in some underground mines to more than 90 percent at some surface mines. In some underground mines, much of the coal may be left untouched as pillars needed to prevent surface collapse. Geologic features, such as folding, faulting, and interlayered rock strata, can mean a reduction in the amount of coal that can be recovered at both underground and surface mines. Currently it is estimated that U.S. recoverable coal reserves total 261 billion short tons.

There are four recognized ranks of coal in the U.S. declassification scheme: anthracite, bituminous coal, subbituminous coal, and lignite. In the United States, coal rank is classified according to its heating value, its fixed carbon and volatile matter content, and, to some extent, on its agglomerating characterstics (or caking properties during combustion). Of the four ranks, bituminous coal accounts for over half (51 percent) of the demonstrated reserve base. Bituminous coal is concentrated primarily east of the Mississippi River, with the greatest amounts in Illinois, Kentucky, and West Virginia. All subbituminous coal (38 percent of the demonstrated reserve base) is west of the Mississippi, with most of it in Montana and Wyoming. Lignite, the lowest-rank coal, accounts for about nine percent of the demonstrated reserve base and is found mostly in Montana, Texas, and North Dakota. Anthracite, the highest-rank coal, makes up less than 2 percent of the demonstrated reserve base and is concentrated almost entirely in northeastern Pennsylvania.

Current world recoverable reserves are estimated to be 1.2 trillion short tons. It is estimated that the United States possesses nearly one-fourth of the world's recoverable coal reserves, about the same as the former Soviet Union. China (16 percent), Australia (9 percent), Germany (7 percent), South Africa (5 percent), and Poland (4 percent) also have significant amounts of recoverable coal reserves.

In 1990, the Energy Information Administration (EIA) held the Coal Reserves Assessment Conference, which led to a plan for improving coal reserves data. That plan was embodied in the Coal Reserves Data Base (CRDB) program, initiated later that year to help meet the growing need for updated data on U.S. coal reserves. The EIA's CRDB program has encouraged the strong participation of State agencies in revising resource and reserve estimates of coal reserves in those States.

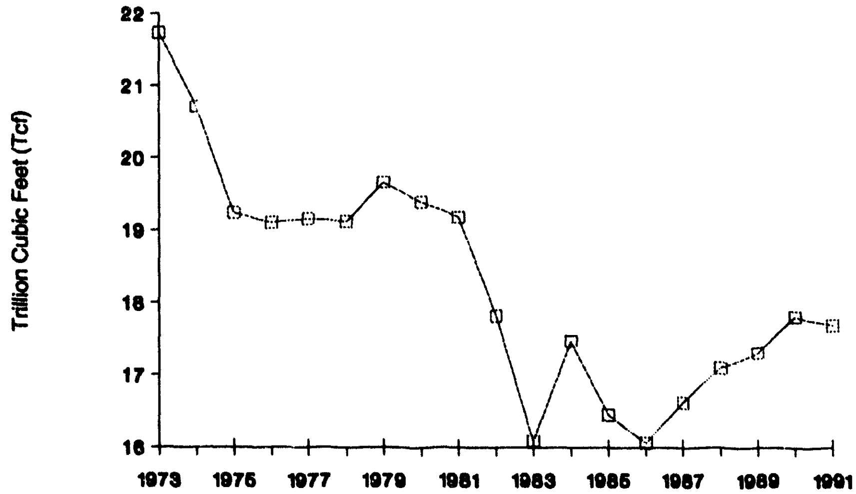
More information on this subject may be found in the EIA publications: *U.S. Coal Reserves: An Update By Heat and Sulfur Content; Coal Data: A Reference; International Energy Annual; Coal Production; Annual Energy Review*; and the British Petroleum Corporation's *Statistical Review of World Energy* (London, England, June 1990).

Natural Gas Production

Natural gas, a combustible gaseous mixture of hydrocarbons, mostly methane, is produced from wells drilled into underground reservoirs of porous rock. When the gas is first withdrawn from the well, it may contain liquid hydrocarbons and nonhydrocarbon gases. The natural gas is separated from these components near the site of the well or at a natural gas processing plant. The gas is then considered "dry" and is sent through pipelines to a local distribution company and, ultimately, to the consumer.

In 1991, dry natural gas production accounted for 27 percent of total U.S. energy production and was produced from over 250,000 wells located in 33 of the 50 States and in Federal waters in the Gulf of Mexico and off the coast of California. Out of total U.S. production of 17.8 trillion cubic feet (Tcf), Texas led all States with 6 Tcf, followed by Louisiana with 4.9 Tcf and Oklahoma with 2.1 Tcf.

U.S. Dry Natural Gas Production, 1973-1991



Source: Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035.

After reaching a peak of 21.7 Tcf in 1973, U.S. production declined as low as 16 Tcf in 1986. Since then production has increased each year, however, it dropped slightly in 1991 totalling 17.8 Tcf. By the year 2000 production is expected to range between 19 and 20 Tcf.

In addition to natural gas production, the U.S. gas supply is augmented by imports from Canada and Algeria, and by supplemental gaseous fuels. Supplemental gas supplies, which in 1991 totalled 112 billion cubic feet (Bcf), include refinery gas, propane-air mixtures, and synthetic natural gas, which is manufactured from petroleum hydrocarbons or from coal. The single largest source of synthetic gas is the Great Plains Synfuels Plant in Beulah, North Dakota, which in 1990 produced 53 Bcf of gas from coal.

Imports of natural gas in 1991 totalled 1.8 Tcf, or over 9 percent of total U.S. consumption. The vast majority of these imports, about 1.7 Tcf, arrive from Canada via pipeline. Gas imported from Algeria, 64 Bcf in 1991, is first cooled to -260 degrees Fahrenheit at which point the gas becomes a liquid. (As a liquid, over 600 cubic feet of natural gas can occupy the same amount of space that one cubic foot of natural gas would at standard conditions.) The liquefied natural gas (LNG) is then transported to the United States on specially designed ships.

Worldwide production of natural gas is dominated by the United States and the former Soviet Union, whose combined production accounted for over 62 percent of the 75.1 Tcf produced in 1991.

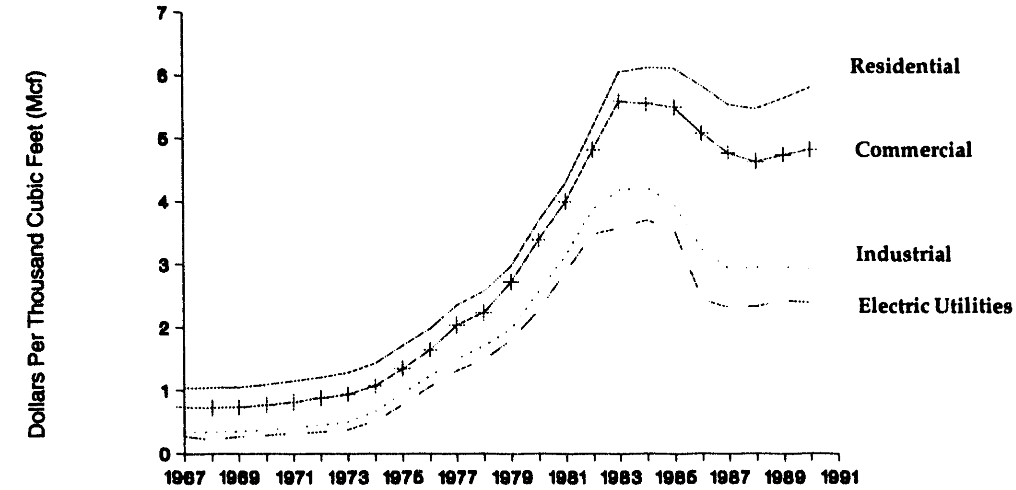
More information on this subject can be found in the EIA publications: *Monthly Energy Review, Natural Gas Annual, International Energy Annual,* and *Annual Energy Outlook.*

Natural Gas Prices

The Natural Gas Policy Act of 1978 (NGPA) mandated the phased decontrol of the wellhead price of "new gas" supplies (generally natural gas from wells drilled after 1976) and continued price control of "old gas" (generally natural gas dedicated to interstate commerce prior to enactment of the NGPA) and certain categories of incentive-priced natural gas. On January 1, 1985, new natural gas prices were decontrolled pursuant to the NGPA. Certain additional volumes of new onshore production were decontrolled on July 1, 1987.

On July 26, 1989, the President signed legislation to remove all remaining natural gas wellhead price controls by 1993. This action was significant, particularly for an industry that historically has been subject to extensive regulation. It continues the trend toward increased operation of free market forces in the natural gas industry. To allow ample time for contracts to be renegotiated, Congress adopted a phase-in schedule for decontrol. In general, price controls will be eliminated when current contracts between producers and buyers expire. All natural gas covered by expired, terminated, or new contracts signed after enactment of the bill was immediately decontrolled. Natural gas produced from any wells drilled after enactment of the bill was decontrolled on May 15, 1991. On January 1, 1993, all price controls on the first sale of natural gas were removed.

Average Price of Natural Gas Delivered to U.S. Consumers, 1967-1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

ENERGY INFORMATION SHEET

Natural gas is extracted from the ground by a producing company. From the well, it may go to a gas processing plant for removal of liquid hydrocarbons, sulfur, carbon dioxide, or other components which naturally occur with methane. Next, a pipeline carries the gas to a local distribution company. The local distribution company, in turn, delivers the natural gas to the end user. A large end user may purchase the natural gas directly from a producer, a natural gas broker or marketer, or a pipeline company. In any event, in most cases, the gas is physically delivered through the pipeline system to the local distribution company and then to the customer.

The average price of natural gas is different for the four end-use sectors: residential, commercial, industrial, and electric utilities. Some of the major factors that influence the end-use sector prices are the amount of natural gas sold, the distribution costs, and the price of competing fuels. During 1973, the critical year of the Arab oil embargo, the residential sector paid an average price of $1.29 per thousand cubic feet; the commercial sector, $0.94 per thousand cubic feet; the industrial sector, $0.50 per thousand cubic feet; and the electric utilities, $0.38 per thousand cubic feet. The national average for that year was $0.73 per thousand cubic feet.

During 1991, the residential sector remained the highest paying sector, its price averaging $5.82 per thousand cubic feet. The average commercial sector price was $4.81 per thousand cubic feet, the industrial sector price was $2.69 per thousand cubic feet, and the electric utilities sector price was $2.18 per thousand cubic feet.

More information on this subject may be found in the EIA publications: *Natural Gas Annual*, *Natural Gas Monthly*, and *Energy Facts*.

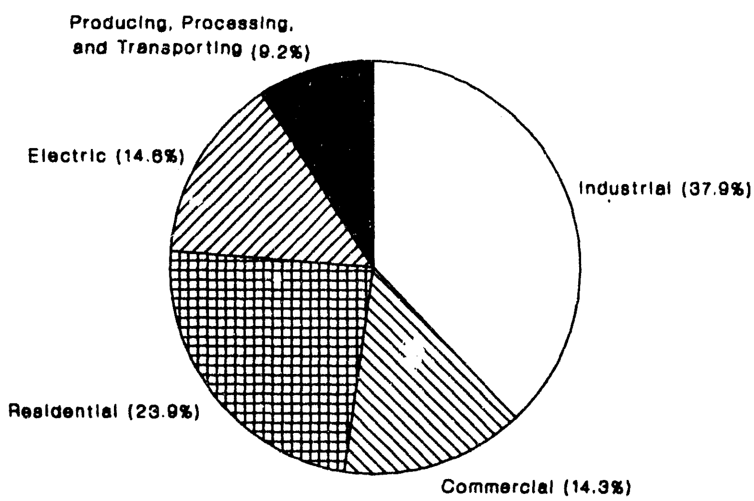
Natural Gas Consumption

Natural gas is best known as the fuel that produces the blue flame that heats our food, our water, and our homes and buildings. It is also used to generate electricity, provide heat for industrial processes, and is used as a raw material to produce petrochemicals.

For centuries, natural gas has been used in various parts of the world. The Chinese, 2,000 years ago, piped natural gas through bamboo poles from shallow wells. They then burned the gas to heat large pans to evaporate sea water for salt. It is believed that the first commercial use of natural gas in the western world was for street lighting in Genoa, Italy, in 1802.

In 1991, the United States consumed over 19 trillion cubic feet (Tcf) of natural gas, which accounted for over 24 percent of all U.S. energy consumption. The industrial sector consumed 7.2 Tcf, or 38 percent of total gas consumption. The residential sector's 4.6 Tcf of consumption was 24 percent of the total, and the commercial sector's 2.7 Tcf was 14 percent. Electric utilities, burning 2.8 Tcf of gas to generate electricity, accounted for 15 percent of total gas consumption. In addition, 1.9 Tcf, or 9 percent of the total, was used in producing, processing, and transporting natural gas. By the year 2010, U.S. consumption of natural gas is projected to range between 20 and 22 Tcf, with most of the increase going towards electricity generation.

U.S. Natural Gas Consumption, 1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

In 1991, the Soviet Union's 25.5 Tcf of consumption and the United States 18.7 Tcf of consumption accounted for almost 60 percent of the world's 74.4 Tcf of natural gas consumption. By the year 2010, total world consumption is expected to range between 103 Tcf and 120 Tcf.

More information on this subject may be found in the EIA publications: *Monthly Energy Review, Natural Gas Monthly, Natural Gas Annual, International Energy Annual, Annual Energy Outlook,* and *International Energy Outlook.*

Natural Gas Reserves

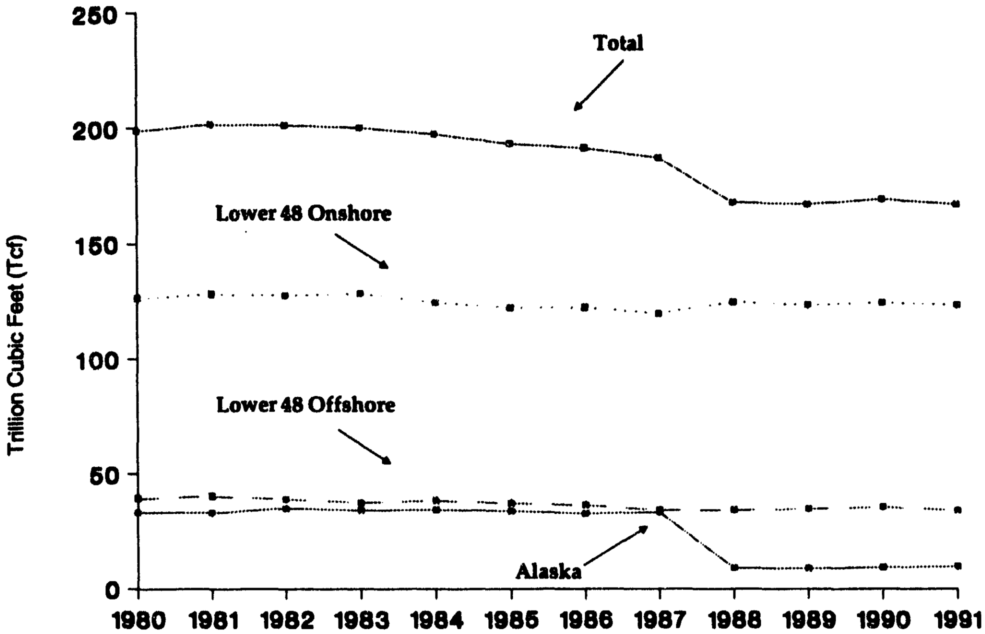
The most common theory about how natural gas was created holds that it was formed from the underground decomposition of organic matter (dead plants and animals). During the decomposition process, much of the carbon and hydrogen in the organic matter was converted to methane, the major component of natural gas. (The chemical formula for methane is CH_4--that is, one molecule of methane contains one carbon atom and four hydrogen atoms.) Large volumes of methane were subsequently trapped in the subsurface of the Earth where the right geological conditions occurred at the right times. Such a place is called a reservoir.

Proved reserves of natural gas are estimated quantities that analyses of geological and engineering data have demonstrated to be economically recoverable in future years from known reservoirs. The natural gas placed in underground storage is not included in proved reserves. It is not necessary that production, gathering, or transportation facilities be actually installed or operative for a reservoir to be considered proved. It is assumed that production will be initiated if and when economically justified.

As of December 31, 1991, the estimated U.S. total proved reserves, wet after lease separation, was 175,325 billion cubic feet (Bcf). ("Wet after lease separation" is the term used to describe the volume of natural gas remaining after removal of lease condensate, a mixture consisting primarily of pentanes and heavier hydrocarbons.) Of those 175,325 Bcf, non-associated gas (natural gas not in contact with significant quantities of crude oil) accounted for 143,508 Bcf. The remaining natural gas occurring with crude oil, either as free gas (associated) or in solution with crude oil (dissolved), accounted for 31,817 Bcf. Estimated proved reserves of dry natural gas in the United States were 167,062 Bcf. (Dry natural gas is the volume of natural gas that remains after the liquefiable hydrocarbon portion has been removed from the gas stream at a natural gas processing plant.) Natural gas reserves resumed a general decrease in 1991 after a one-year rise in 1990. The 1.3-percent decrease represented a loss of 2,284 Bcf, with the four leading gas-producing areas (Texas, Gulf of Mexico Federal Offshore, Oklahoma, and Louisiana) all sustaining substantial reserves declines. Partially offsetting these declines were increases in three States with large coalbed methane reserves additions (Alabama, New Mexico, and Colorado).

In addition to proved natural gas reserves are large volumes of natural gas classified as undiscovered recoverable resources. Those resources are expected to exist because the geologic settings are favorable. Over half of all onshore undiscovered resources are located in the Alaska and Gulf Coast regions. Over one-third of all undiscovered resources are estimated to be in Federal offshore areas, primarily near Alaska, in the Gulf of Mexico, and along the Atlantic Coast.

U.S. Dry Natural Gas Proved Reserves, 1980-1991



Source: Energy Information Administration, *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, 1980 through 1991 annual reports, DOE/EIA-0216.

More information on this subject may be found in the EIA publications: *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*; *Annual Energy Review*; and *Energy Facts.*

Electricity Generation

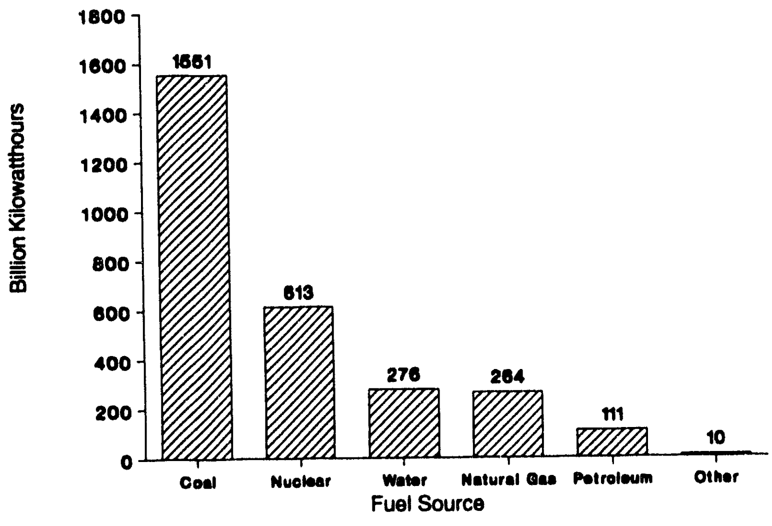
Consumers expect electricity to be available at the flick of a switch. Satisfying these instantaneous demands requires an uninterrupted flow of electricity. In order to meet this requirement, utilities operate several types of electric generating units powered by different fuel sources: coal, uranium, water, natural gas, petroleum, and non-water renewable energy sources.

Steam-electric generating units burn fossil fuels such as coal, natural gas, and petroleum. The steam turns a turbine that produces electricity through an electrical generator. Natural gas and petroleum are also burned in gas turbine generators where the hot gases produced from combustion are used to turn the turbine, which in turn spins the generator to produce electricity. Additionally, petroleum is burned in generating units with internal-combustion engines. The combustion occurs inside cylinders of the engine, which is connected to the shaft of the generator. The mechanical energy provided from the engine drives the generator to produce energy.

Coal was the fuel used to generate the largest share (55 percent) of electricity in 1991, 1,551 billion kilowatthours (kWh). (This is over one and a half times the annual electricity consumption of all households in the United States (955 billion kWh).) Natural gas was used to generate 264 billion kWh (9 percent), and petroleum accounted for 111 billion kWh (4 percent).

In nuclear-powered generating units, the boiler is replaced by a reactor in which the fission of uranium is used to make steam to drive the turbine. Nuclear generating units accounted for the second largest share (22 percent) of electricity generation in the United States in 1991, 613 billion kWh.

U.S. Net Electricity Generation, 1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

Hydroelectric power units use flowing water to spin a turbine connected to a generator. In a falling water system, water is accumulated in reservoirs created by dams, then released through conduits to apply pressure against the turbine blades to drive the generator. In a run-of-the-river system, the force of the river current applies the pressure to the turbine blades to produce electricity. In 1991, hydroelectric generation had the third largest share (10 percent) of electricity production at 276 billion kWh.

Nonwater renewable sources of electricity generation presently contribute only small amounts (less than 1 percent) to total power production. These sources include geothermal, refuse, waste heat, waste steam, solar, wind, and wood. Electricity generation from these sources in 1991 totalled 10 billion kWh.

Total U.S. electricity production in 1991 was 2,825 billion kWh, 1 percent greater than the 1990 total of 2,808 billion kWh.

More information on this subject may be found in the EIA publications: *Annual Energy Review*, *Electric Power Monthly*, and *Electric Power Annual*.

Electricity Prices

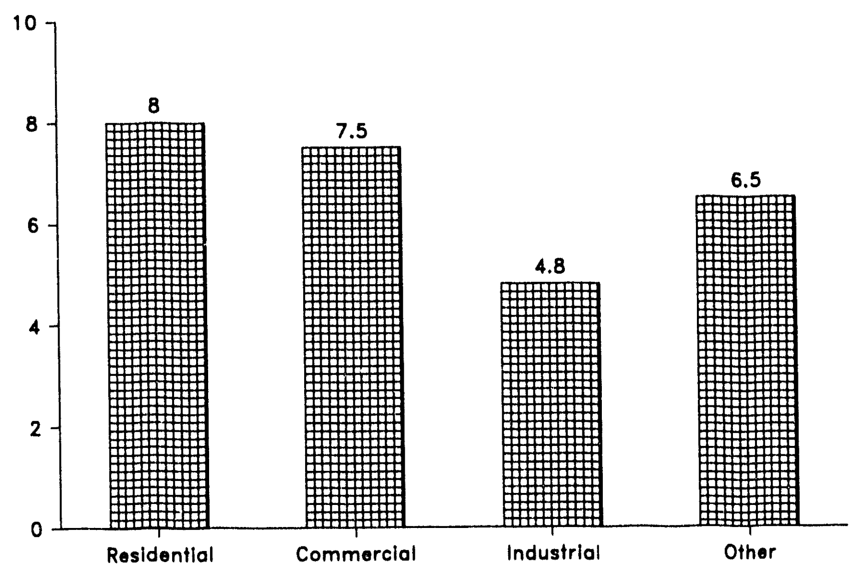
Electricity prices, or rates, are the fees an electric utility company charges its customers for service. An electric bill is computed on the basis of the individual customer's rate, the level of consumption, and other charges, such as taxes and fuel adjustments.

Electric utility companies charge their customers different rates, depending on the type of customer and on the customer's electricity needs. That collection of rates is called a tariff. The tariff is designed to provide the privately owned electric utility with enough income to allow investors to earn a cash return and cover operation and maintenance costs. Most of the larger utilities operate as regulated franchises, meaning that the prices they charge are subject to public review, often by a State public utility commission.

Publicly owned electric utilities are nonprofit, local government agencies established to provide service to their communities and nearby consumers at cost, returning excess funds to the consumer in the form of community contributions, more economic and efficient facilities, and lower rates. Publicly owned electric utilities (which number approximately 2,000) include municipals, public power districts, State authorities, irrigation districts, and other State organizations.

Average retail prices of electricity are calculated by dividing utility revenue by retail sales. The resulting measurement is the cost, or average revenue per kilowatthour, of electricity sold. (A kilowatthour is equal to one watt of power supplied to an electric circuit steadily for 1,000 hours).

Average Cents Per Kilowatthour By Sector, 1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

Electric utilities usually offer three primary classes of service: residential, commercial, and industrial. The average price per kilowatthour for residential consumers is generally higher than for any other sector due in part to higher costs associated with serving many consumers who use relatively small amounts of electricity. The industrial sector has the lowest rates due to the economies of serving a few consumers who use relatively large amounts of electricity.

Because of the type and availability of capacity and the cost of fuel, the average price for electricity differs across U.S. Census divisions. The New England and Middle Atlantic Census Divisions tend to have an average price that is higher than average because of their reliance on petroleum, whereas the East and West South Central Divisions rely on gas-fired generation and the East North Central and South Atlantic Divisions rely on coal-fired generation. Petroleum is generally a more expensive energy source than coal and natural gas. Because the Mountain Census Division relies on less expensive, locally mined coal, the price in this region is usually below the national average for all classes of consumers.

During the first half of the century, the national average price of electricity decreased as more efficient generating units were brought into service. This general trend has continued. The average real price of electricity to all sectors in 1991 (that is, the price adjusted to reflect the purchasing power of the dollar) was 14 percent below the price in 1960. However, the apparent stability in electricity prices masked fluctuations that occurred throughout the period. For example, following the oil embargo in 1973 and 1974, electricity prices increased rapidly because of escalation in the costs of fuel, labor, materials, capital, and services to electric utilities.

More information on this subject may be found in the EIA publications: *Annual Energy Review*, *Electric Sales and Revenue*, and *Electric Power Annual.*

Electricity Sales

The electric utility industry began in 1882 with the establishment of Thomas Edison's power station in New York City. The use of electricity has been growing ever since. It is vital to virtually every aspect of our economy.

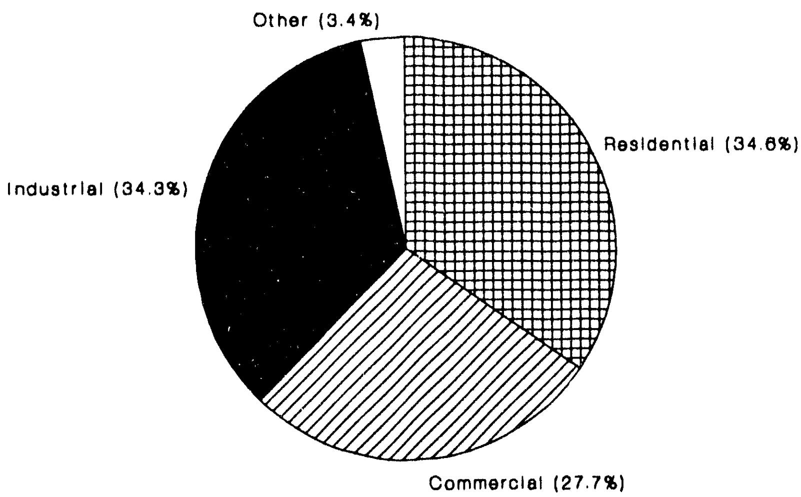
Electricity sales can be defined as the number of kilowatthours (1 kWh=1,000 watthours) sold during a given period of time. Sales are normally classified according to the type of customer or service using the electricity, such as residential, commercial, industrial, and "other" which includes public street and highway lighting.

In 1991, U.S. electric utilities generated 2,825,023 gigawatthours (1 GWh=1 billion watthours) of electricity and sold an estimated 2,762,003 GWh to their consumers. This amount represents about a 2-percent increase over 1990, when total sales were about 2,712,555 GWh. In 1973, by contrast, total sales were 1,712,909 GWh.

Since 1980, sales to residential consumers have been increasing at an average rate of 2 percent per year. Residential consumers, in 1991, purchased 955,417 GWh, an increase of 3 percent over the amount purchased the previous year. The 1991 residential sales accounted for 34 percent of total sales. Among the nine Census divisions, the South Atlantic Division had the largest annual sales to residential consumers, both in 1991 (218,512 GWh) and in 1990 (211,390 GWh).

Since 1980, sales to commercial consumers have been increasing at an average annual rate of 4.2 percent. The South Atlantic Division realized the largest volume of commercial sales in 1991 (157, 340 GWh).

Share of Electricity Sales, 1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

Industrial consumers in 1991 purchased 34 percent of sales to consumers, or 946,583 GWh, about 0.1 percent more than in 1990. Other sales (public street and highway lighting, sales to public authorities, and sales to railroads and railways) were 94,339 GWh, over 3 percent of total sales to all consumers and slightly more than the amount sold for similar purposes in 1990.

More information on this subject may be found in the EIA publications: *Electric Power Annual, Electric Power Monthly, Energy Facts,* and *Annual Energy Review.*

Electricity Capability

The United States has the largest electrical system in the world, with over twice the generating capability of any other country. (Capability is a measure of the steady hourly output that a generating system is able to supply.) Electricity capability in the United States at the end of 1991 was 741 gigawatts (GW). (One gigawatt is equal to one million kilowatts, or slightly larger than the average capability of a nuclear reactor in the United States.) Of this total capability, 693 GW were owned by utilities and 48 GW were owned by nonutility sources such as industrial plants, independent power producers, and cogenerators (generating facilities that produce electricity and another form of useful thermal energy used for industrial, commercial, heating, or cooling purposes).

Even with such a large electrical system, there are concerns as to whether there is sufficient capability to meet future demand, and what options are available to electricity suppliers for meeting future needs. Existing capacity is forecast to be sufficient to meet demand through the mid-1990's, with few large capacity generators required to be constructed over the short term. Electricity suppliers are expected to utilize existing capacity more extensively and to extend the service life of many existing units. Power purchases from nonutility sources and imports from Canada and Mexico are also expected to provide increased contribution to meeting the Nation's electricity needs. Large additions to capacity are expected to be needed after the year 2000.

Net electricity imports and purchases from nonutilities made up 4 percent of the electricity needed by utilities to meet customer requirements in 1989 and 1990, and this share is expected to double by 2000. The degree of reliance on these methods of supply varies according to geographic region. The New England States relied on net imports and nonutility supply for 14 percent of customer requirements in 1990, and this percentage is expected to increase to 24 percent by 2000. States in the West had the largest reliance on nonutility purchases alone in 1990, purchasing over 18 percent of its customer requirements from such sources. This percentage is expected to increase to 21 percent by 2000, with the region retaining its ranking as the most reliant upon nonutility purchases.

Electric utilities are also considering repowering as a cost-effective means of meeting future energy requirements. Repowering generally consists of modifying old coal-fired generating units by replacing the boiler with a new combustion technology which results in better performance and an increase in capacity. In some cases an existing steam-electric plant (steam produced from fuel burned in a boiler powers a turbine, which powers the generator) is reconfigured as a combined cycle plant by adding a gas turbine (the turbine which spins the generator is powered by hot gases produced from combustion of fuel in a high-pressure chamber). Other technologies repower with clean coal technology, which involves replacing the boiler and furnace in an old plant with new, cleaner-burning, high-efficient coal burning or gasification technology.

Another option utilities are choosing is life extension or plant refurbishing. Although life extension adds little, if any, new generating capacity, it can add about 20 years of life to aged plants nearing retirement and is less expensive than repowering.

More information on this subject may be found in the EIA publications: *Annual Energy Outlook; Electric Power Annual; Commercial Nuclear Power: Prospects for the United States and the World; World Nuclear Fuel Cycle Requirements;* and *Energy Facts.*

Nuclear Power Generation

Electricity has been generated by burning fossil fuels (coal, oil, and gas) since before the turn of the century. For three decades, however, a nonfossil fuel, uranium, has also been used to produce electricity. The first nuclear power plant went into commercial operation in 1957 at Shippingport, Pennsylvania. Since then, the use of nuclear-generated electricity has grown substantially in the United States. By the end of 1991, there were 111 units in operation that produced 613 billion net kilowatthours, or 21.7 percent of total U.S. electricity generation.

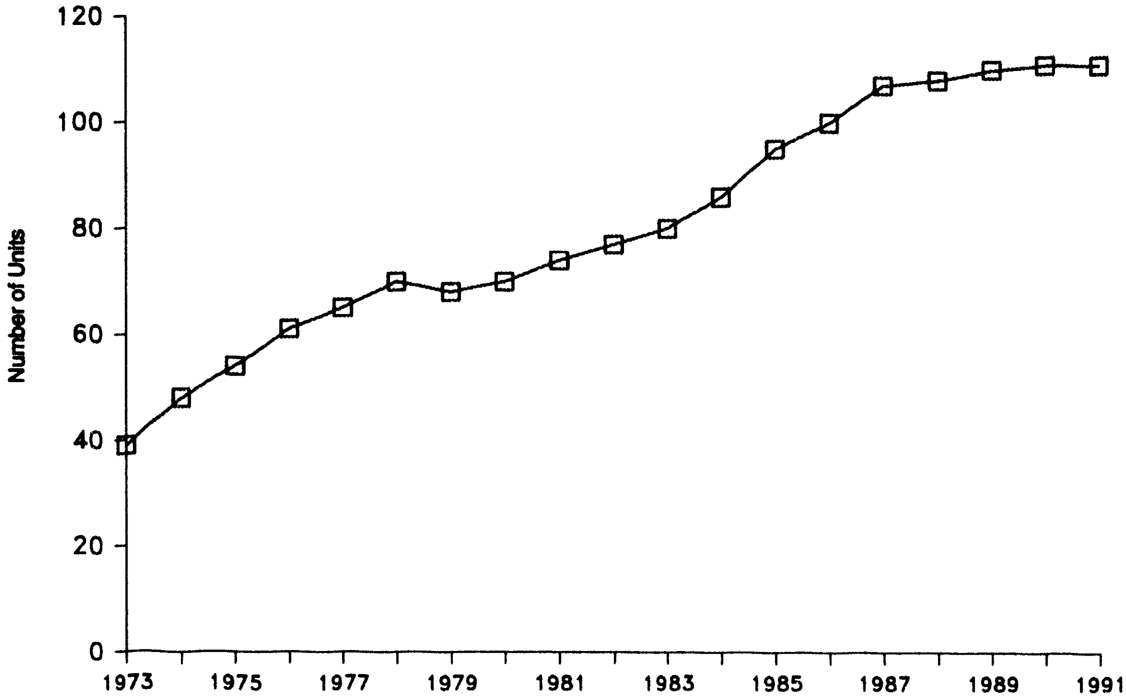
Uranium occurs in nature in combination with small amounts of other elements. Economically recoverable uranium deposits have been discovered principally in the western United States, Australia, Canada, Africa, and South America. A ton of uranium ore mined in the United States yields about 7 pounds of uranium oxide (U_3O_8). Uranium ore must be chemically processed, enriched, and formed into pellets before it can be used as a fuel.

Uranium fuel pellets are loaded into hollow tubes called fuel rods. Hundreds of fuel rods form fuel assemblies that, along with control rods, are placed into a nuclear reactor core and then submerged in water. Like fossil fuels, the resulting uranium fuel produces heat that turns water into steam. The steam turns blades in a turbine connected to an electrical generator. However, heat is produced differently in a nuclear reactor than in a fossil fuel power plant.

The nucleus of an atom consists of combinations of protons and neutrons -- each of about equal weight. Energy in a nuclear reactor is derived from a process called nuclear fission, in which a neutron strikes the nucleus of a uranium atom and is absorbed. The absorption of the neutron makes the nucleus unstable, causing it to split into two atoms of lighter elements and release heat and new neutrons. The heat is used to produce electricity, while the neutrons can potentially be absorbed by other atoms of uranium, resulting in more nuclear fissions. This continuing process of fissioning is called a chain reaction. It is sustained because, for every atom of uranium fissioned by a neutron, new neutrons are released to continue the process.

The United States has more nuclear generating capacity than any other country in the world; next is France, third is the former Soviet Union, and fourth is Japan. In 1991, U.S. nuclear capacity constituted 30.6 percent of total nuclear capacity for countries belonging to the Organization for Economic Cooperation and Development. In 1983, France became the first country to produce at least 50 percent of its electricity from nuclear power plants; in 1984, Belgium became the second country to do so. Although the 1986 Chernobyl accident in the former Soviet Union caused several countries to re-evaluate their programs, the use of nuclear-generated electricity continues to grow worldwide. For example, in 1991, France produced 73 percent of its electricity from nuclear power plants and Sweden produced 52 percent.

Operable Nuclear Units in the United States, 1973-1991



Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

More information on this subject may be found in the EIA publications: *Annual Energy Review; Electric Power Annual; Commercial Nuclear Power: Prospects for the United States and the World; World Nuclear Fuel Cycle Requirements;* and *Energy Facts.*

Renewable Energy

While supplies of fossil fuels and uranium are limited and irreplacable, renewable energy sources -- such as the sun (solar), wind, water (hydropower), wood and other plant material (biomass), waste, and the heat of the earth (geothermal) -- are practically inexhaustible or can be regenerated or recycled.

Some renewable energy sources, such as wood and other biomass, can be burned directly to provide heat for homes or fuel for boilers. Some biomass is converted to alcohol and used as automobile fuel. Solar collectors, which are often seen on rooftops, are used for space heating, hot water, and to heat swimming pools. All renewable energy sources, however, can be used to generate electricity. Among the renewable sources powering electricity generation, hydropower provides by far the largest contribution to United States energy supplies. In 1991, hydroelectric generation yielded about 282,000 gigawatthours of electricity, 9 percent of all electricity generated in the country. (A watthour is a unit of electrical energy equal to 1 watt of power steadily supplied to or taken from an electric circuit for 1 hour. A gigawatthour equals a billion watthours.)

Other renewable sources -- wood, waste, geothermal, wind, and solar -- were responsible for about 69,000 gigawatthours, representing about 2 percent of total generation. Nearly 85 percent of this electricity was generated by independent power producers and sold to electric utilities; the remaining 15 percent was generated by the utilities themselves.

The sun is expected to radiate energy at a fairly constant rate for a few billion years. The electromagnetic waves from the sun can be converted to other forms of energy, such as heat and electricity, which can be utilized by people. In order for solar energy to be used extensively, certain major problems must be dealt with. The sun does not shine steadily: when it is shining, it is not always at the same intensity; and some of the rays are bent or reflected by water droplets and dust particles in the atmosphere. The sun's rays have to fall on a relatively large area in order for enough usable energy to be collected. Where high temperatures are required, a "concentrating collector" can be used to focus the rays that fall on a large area onto a much smaller area.

The major economic applications of solar energy at present are for heating residences and other buildings. Solar energy can also be converted into usable electricity either by means of a photovoltaic cell (based on the element silicon) or by using solar radiation to heat a fluid which, in turn, drives a turbine connected to a conventional electric generator. In 1991, solar energy was used to produce about 780 gigawatthours of electricity.

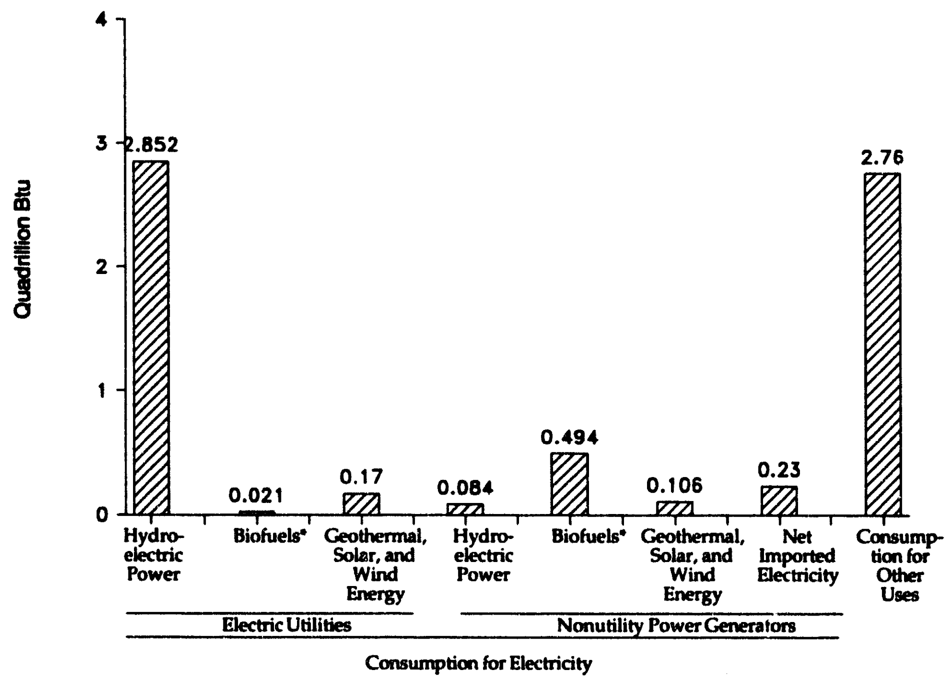
The wind has been used as a source of energy for centuries. From 1880 to 1930, over 6 million windmills generated electric power in the western United States. The rising cost of fossil fuels, coupled with technological advances in windmill design, has made wind an attractive alternative energy source in the last decade. The western Great Plains and the New England and Pacific coastlines offer the most sustained usable wind velocities.

Wood and waste used by electric utilities for producing electricity include wood chips, sawdust, garbage, chemically inert gas, bagasse (plant refuse), and sewerage plant gas. Wood once supplied up to 90 percent of the energy needs of our country. In recent times, the demand for wood rose and fell with the price of fossil fuels. In 1991, wood and waste were used to generate over 50,000 gigawatthours of electricity.

Geothermal energy is heat generated by natural processes beneath the earth's surface. It is recovered as steam and hot water. The steam is harnessed to run generators. Most of the potential for using geothermal energy in the United States is in California, other far western States, and the Gulf Coast States. By far the largest geothermal facilities now in operation are at the Geysers in northern California.

The use of renewable energy sources in the United States is not expected to approach that of the major energy sources in the near future. However, under appropriate conditions and for special purposes, renewable energy sources are proving to be of great value.

Renewable Energy Consumption Estimates (By Use), 1991



*Biofuels are fuelwood, wood byproducts, waste wood, municipal solid waste, manufacturing process waste, and alcohol fuels.

Source: Energy Information Administration, *Annual Energy Review*, 1992, DOE/EIA-0384(92).

More information on this subject may be found in the EIA publications: *Annual Energy Review*, *Monthly Energy Review*, and *Electric Power Monthly*.

Degree-Days

Freezing winter weather or a long, sweltering summer--either one can increase your utility bills. But how much of the rise in the cost is a result of the weather? You can find out by using a unit of measure called the "degree-day."

A "degree-day" compares the outdoor temperature to a standard of 65 degrees Fahrenheit (F): the more extreme the temperature, the higher the number of degree-days. Thus, degree-day measurements can be used to describe the effect of outdoor temperature on the amount of energy needed for space heating or cooling.

Technically, a degree-day is a 1-degree F difference between 65 degrees F and the mean outdoor air temperature on a given day. Hot days, which may require the use of energy for cooling, are measured in cooling degree-days. On a day with a mean temperature of 80 degrees F, for example, 15 cooling degree-days would be recorded. Cold days are measured in heating degree-days. For a day with a mean temperature of 40 degrees F, 25 heating degree days would be recorded. Two such cold days would result in a total of 50 heating degree-days for the 2-day period.

By studying degree-day patterns in your area, you can evaluate the increases or decreases in your heating or air-conditioning bills from year to year. In some areas, degree-day information is published in the local newspapers, usually in the weather section. Information may also be available from your local utility. Its public relations department may be able to tell you the number of degree-days in the last billing period and how it compares to the number of degree-days in previous billing periods. You may also be able to obtain degree-day totals for longer periods.

By studying degree-day patterns for the United States, you can better understand changes in the U.S. energy consumption. Degree-day data for U.S. regions or the country as a whole usually are population-weighted, since hot or cold weather in a densely populated area affects energy use more than the same weather in a sparsely populated area.

The Energy Information Administration provides information about degree-days in its publication *Monthly Energy Review (MER)*. A degree-day table lists the population-weighted degree-days that occur in each region of the United States. It compares monthly and year-to-date totals to similar totals for previous periods.

The degree-day table below shows that, in the Middle Atlantic States, January 1992 was warmer than January 1991. In January 1992, 1,036 heating degree-days were recorded, down from 1,064 degree-days (still warmer than normal) in January 1991. On the other hand, the South Atlantic States were cooler in January 1992 (596 heating degree-days) than in January 1991 (575 heating degree-days), but warmer than normal.

Population-Weighted Heating Degree-Days, 1991-1992

Census Divisions	January 1 through January 31					Cumulative July 1 through January 31				
				Percent Change					Percent Change	
	Normal[a]	1991	1992	Normal to 1992	1991 to 1992	Normal[a]	1991	1992	Normal to 1992	1991 to 1992
New England Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	1,229	1,200	1,155	-6.0	-3.8	3,649	3,239	3,434	-5.9	6.0
Middle Atlantic New Jersey, New York, Pennsylvania	1,155	1,064	1,036	-10.3	-2.6	3,293	2,844	2,994	-9.1	5.3
East North Central Illinois, Indiana, Michigan, Ohio, Wisconsin	1,299	1,280	1,108	-14.7	-13.4	3,660	3,505	3,485	-4.8	-.6
West North Central Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota	1,410	1,423	1,091	-22.6	-23.3	3,953	3,948	3,776	-4.5	-4.4
South Atlantic Delaware, Florida, Georgia, Maryland and the District of Columbia, North Carolina, South Carolina, Virginia, West Virginia	666	575	596	-10.5	3.7	1,812	1,466	1,643	-9.3	12.1
East South Central Alabama, Kentucky, Mississippi, Tennessee	802	736	738	-8.0	.3	2,187	1,873	2,034	-7.0	8.6
West South Central Arkansas, Louisiana, Oklahoma, Texas	600	622	542	-9.7	-12.9	1,494	1,475	1,446	-3.2	-2.0
Mountain Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	1,015	1,032	958	-5.6	-7.2	3,210	3,253	3,143	-2.1	-3.4
Pacific California, Oregon, Washington	596	564	536	-10.1	-5.0	1,786	1,741	1,585	-11.3	-9.0
U.S. Average[b]	961	921	845	-12.1	-8.3	2,718	2,510	2,538	-6.6	1.1

[a] Normal is based on calculations of data from 1951 through 1980.
[b] Excludes Alaska and Hawaii
Source: Energy Information Administration, *Monthly Energy Review*, February 1992, Table 1.11.

The data show that, on the average, the United States was warmer in January 1992 than in January 1991, and warmer than normal for both years. The National Oceanic and Atmospheric Administration (NOAA) is a second source of information about degree-days for the country as a whole.

Preliminary Data, 1992-1993

The Middle Atlantic States were warmer in January 1993 than they had been in January 1992. In January 1993, 981 heating degree-days were recorded, down from 1,036 degree-days (still warmer than normal) in January 1992. On the other hand, the Pacific States were cooler in January 1993 (604 heating degree-days) and cooler than normal for the period than in January 1992 (536 heating degree-days.)

More information on this subject may be found in the Energy Information Administration's publication *Monthly Energy Review*, or from the National Climatic Data Center, Federal Building, Asheville, North Carolina 28801.

Apples, Oranges, and Btu

Assume that you have been assigned the responsibility of purchasing fuel for a large electric utility company. The 1991 average prices of fuel delivered to electric utilities were $30.02 per short ton of coal, $16.09 per 42-U.S. gallon barrel of oil, and $2.20 per thousand cubic feet of natural gas. Tons, barrels, cubic feet -- how do you compare apples and oranges?

To make meaningful comparisons of energy commodities, you must convert physical units of measure (such as weight or volume) and the energy content of each fuel to comparable units. One practical way to compare different fuels is to convert them into British thermal units (Btu). The Btu is a precise measure of energy -- the amount of energy required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

A single Btu is insignificant in terms of the Nation's energy consumption, or even in terms of energy use in a single household. One Btu is approximately equal to the energy released in the burning of a wood match. The average single-family household consumed 98 million Btu of energy in a recent year. So on the family level, 1 million Btu is a meaningful quantity.

Billions, trillions, and quadrillions of Btu are used to measure quantities of energy larger than those consumed by typical households. (Written out, 1 quadrillion is a 1 with 15 zeros.) To put those quantities in perspective, 1 million Btu equals about 8 gallons of motor gasoline. One billion Btu equals all the electricity that 30 average Americans use in 1 year. One trillion Btu is equal to 474 100-ton railroad cars of coal intended for electric utilities. And 1 quadrillion Btu is equal to 470 thousand barrels of oil every day for 1 year. In 1991, the Nation used 81 quadrillion Btu of energy: 33 quadrillion Btu of petroleum, 20 quadrillion Btu of natural gas, 19 quadrillion Btu of coal, and 10 quadrillion Btu of other energy sources.

British thermal units are useful for more than just calculating volumes of consumption. Price equivalents are usually expressed in cents per million Btu, and the homeowner often thinks of Btu in terms of dollars and cents. In 1991, a ton of coal used to generate electricity cost more than twice as much as a barrel of oil. The barrel of oil, however, contained about 6.6 million Btu, while the ton of coal contained 22 million Btu, over three times as much energy. On a Btu basis, coal was cheaper. (Of course, cost is not the only consideration in selecting a fuel. Environmental restrictions, equipment costs, and other factors must also be taken into account.)

By use of the Btu, it is possible to compare prices not only for different forms of fuel, but also for different products from the same fuel. For example, motor gasoline contains an average of 5.25 million Btu per barrel, while jet fuel (kerosene-type) contains 5.67 million Btu per barrel. At $33.47 per barrel for motor gasoline and $27.38 per barrel for jet fuel in 1991, motor gasoline costs $6.37 per million Btu and jet fuel costs $4.83 per million Btu.

By itself, a single Btu does not mean very much. For the average consumer who uses millions of Btu per year, however, it is a term well worth knowing.

More information on this subject may be found in the EIA publications: *Monthly Energy Review; Annual Energy Review; State Energy Data Report;* and *Household Energy Consumption and Expenditures, Cost and Quality of Fuels Electric Utility Plants.*

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