DOE/EIA-0578(96)
Distribution Category UC-950

Energy Information Sheets

July 1998

Energy Information Administration
National Energy Information Center
U.S. Department of Energy
Washington, DC 20585

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 public. The *Energy Information Sheets* was developed to provide general information on various aspects of fuel production, prices, consumption, and capability. Additional information on related subject matter can be found in other Energy Information Administration (EIA) publications as referenced at the end of each sheet.

Questions concerning the contents of this publication should be directed to NEIC, (202) 586-8800. Questions concerning the publication itself should be directed to Marion King at (202) 586-1183. This issue of *Energy information Sheets* supersedes the previous issues.

Contents

	Page
Apples, Oranges and Btu	1
Coal Demand	3
Coal Prices	5
Coal Production	7
Coal Reserves	9
Electricity Capability	11
Electricity Generation	13
Electricity Prices	15
Electricity Sales	17
Nuclear Power Generation	19
Crude Oil and Petroleum Product Prices	21
Crude Oil Production	23
Petroleum Product Consumption	25
Petroleum Reserves	27
Propane	29
Natural Gas Consumption	31
Natural Gas Reserves	33
Natural Gas Supply	35
Residential Uses of Energy	37
Renewable Energy	39
Degree-Days	41

Apples, Oranges and Btu

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.

Assume that you have been assigned the responsibility of purchasing fuel for a large electric utility company. The 1996 average prices of fuel delivered to electric utilities were $26.45 per short ton of coal, $19.95 per 42-gallon barrel of oil, and $2.69 per thousand cubic feet of natural gas. Tons, barrels, cubic feet--how do you compare apples and oranges?

A single British thermal unit (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 and 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 1996, the Nation used 90 quadrillion Btu of energy: 36 quadrillion Btu of petroleum, 23 quadrillion Btu of natural gas, 20 quadrillion Btu of coal, and 11 quadrillion Btu of other energy sources.

Btu 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 1996, 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 6.2 million Btu, while the ton of coal contained 21 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 $31.00 per barrel for motor gasoline and $22.43 per barrel for jet fuel in 1996, motor gasoline costs $5.90 per million Btu and jet fuel costs $3.96 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 can be found in the following EIA publications: *Monthly Energy Review*, *Annual Energy Review,* and *Electric Power Annual*.

Coal Demand

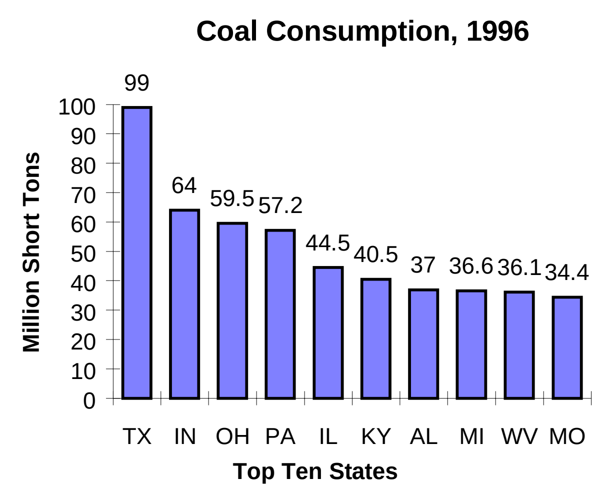
During 1996, a record 983 million short tons of coal was consumed in the United States. The greatest demand for coal was by electricity generating plants that burn coal to produce electricity. In 1996, 875 million short tons were used by electric utilities, accounting for 89 percent of coal consumed in the United States. About 56 percent of the electricity generated was by coal-fired plants. Each ton of coal consumed at an electric power plant produces about 2,000 kilowatthours of electricity. A pound of coal supplies enough electricity to light ten 100-watt bulbs for about an hour.

The second largest sector of coal demand was for industrial use, which amounted to 71 million short tons in 1996. 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.

Coal exports in 1996, about 8 percent of demand, totaled 90 million short tons, a 2 percent increase from 1995 and the highest level since 1992. The leading destinations for U.S. coal exports were Japan, Canada, Italy and the Netherlands, which accounted for 43 percent of the total. West Virginia was the leading source of U.S. coal distributed abroad during 1996, with foreign shipments totaling 42 million short tons, representing 46 percent of total foreign distributions.

In 1996, 32 million short tons of coal were consumed by coke plants. Coal is converted into coke through a process known as "carbonization." 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 slightly less than 6 million short tons in 1996.

Over 611 million short tons of coal transported within the United States in 1996 were moved by rail. River barge shipping in the inland waterways system was the next most prevalent mode, carrying about 136 million short tons. Slightly more coal was shipped by truck than was carried by tramway, conveyors, and coal slurry pipeline. The Nation's only coal slurry pipeline, the 273-mile-long Black Mesa line, carries about 4.5 million tons of coal annually. 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.



Source: Energy Information Administration, *Coal Industry Annual* 1996, DOE/EIA-0584(96).

Texas led all States in coal consumption in 1996, using 99 million short tons. Indiana and Ohio were second and third, respectively. These three States accounted for almost 23 percent of the total U.S. coal consumption for the year. North Dakota, which ranked tenth in coal use, is the site of one coal gasification plant that uses 18,000 tons of lignite per day to produce about 160 million cubic feet per day of synthetic natural gas.

More information on this subject can be found in the following EIA publications: *Coal Industry Annual, Quarterly Coal Report*, *Coal Data: A Reference,* and *Monthly Energy Review*.

Coal Prices

In the early 1900s, 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. In 1996, coal receipts at the electric utilities totaled a record 862 million short tons. About 78 percent of the coal produced in the United States in 1996 was delivered to domestic power plants. Of the total coal consumed in the United States, 89 percent was used for generating electricity--accounting for over 56 percent of the total electricity produced.

During the early 1970s, 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 1996, on a dollars-per-million-Btu basis, petroleum was the most expensive fossil fuel ($3.16), natural gas was second ($2.64), and coal was least expensive ($1.29). 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. The average spot-market price for coal delivered to the electric utilities was $26.97 per short ton in 1996.

The average coal export price for 1996 was $40.76 per short ton. Coal exports in 1996 totaled 90 million short tons, a 2-percent increase from 1995. Higher demand for U.S. steam coal in Canada, Mexico, and Japan accounted for most of the increase in U.S. exports, which was partially offset by less demand from European markets. The total coal imports for 1996 fell to an annual level of 7.1 million short tons, slightly less than 1995. The average coal import price for 1996 was $33.45 per short ton, down from $34.13 per short ton in 1995.

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 1980s. From 1991 to 1996, it decreased from $48.88 per short ton to $47.33 per short ton.

Average Mine Price of U.S. Coal, 1986-1996

Year	Dollars per Short Ton
1986	23.79
1987	23.07
1988	22.07
1989	21.82
1990	21.76
1991	21.49
1992	21.03
1993	19.85
1994	19.41
1995	18.83
1996	18.50

Source: Energy Information Administration.

The average mine price per short ton of coal in 1996 was $18.50. This was a drop of 2 percent from 1995 and the 14th straight year of decline. 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.

More information on this subject can be found in the following EIA publications: *Electric Power Monthly*, *Coal Industry Annual*, *Quarterly Coal Report*, and *Coal Data: A Reference.*

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 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; 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 62 percent of the coal produced in the Nation is bituminous coal.

U.S. coal production in 1996 reached a record 1,064 million short tons. This surpasses the 1995 coal production by 31 million short tons.

In 1996, Wyoming was the Nation's leading coal-producing State with production of 278,440 thousand short tons, which was about 26 percent of the national total. West Virginia ranked second, with 165,717 thousand short tons, and Kentucky was third, with 150,063 thousand short tons. Together, these three States accounted for 56 percent of total U.S. coal production.

Coal production for States east of the Mississippi River rose to 564 million short tons. The States with the greatest increase in production were Pennsylvania, Indiana, and West Virginia. Only three States showed production declines: Alabama, Tennessee, and Virginia.

Total U.S. productivity in 1996 reached 5.7 short tons per miner per hour. The average number of miners working daily fell to 83,462. The average mine price of coal fell for the 14th consecutive year to $18.50 per short ton.

Coal production west of the Mississippi River in 1996 reached a record 500 million short tons, despite fewer mines in the region and 1,579 fewer miners. Wyoming's coal output, which was 15 million short tons higher than in 1995, accounted for most of the growth. Miner productivity in the region rose 10 percent to 15.66 tons per miner per hour, in part due to the use of new, upgraded equipment at the mines.

In 1996 there were 200 mines in the United States that produced 1 million or more short tons. They produced 74 percent of the total national production, although they represented only 11 percent of active mines. The Nation's largest coal mine, located in Campbell County, Wyoming, continued to be the Black Thunder Mine, with over 39 million short tons produced. Of the 200 large mines, 132 mines east of the Mississippi River produced over 303 million short tons, and 68 mines west of the Mississippi River produced 488 million short tons.

Federal and Indian lands have become increasingly important sources of coal. The 354 million short tons produced from these lands in 1996 accounted for about 33 percent of the total U.S. coal output. Federal coal lands produced 328 million short tons in 10 States, and Indian coal lands yielded 26 million short tons in three States.

An Indian coal lease is granted to a mining company to produce coal from Indian lands in exchange for royalties and other revenues. A Federal coal lease is granted to a mining company from land owned and administered by the Federal Government in exchange for royalties and other revenues.

Preliminary numbers show that world coal production increased to 5.2 billion short tons in 1996. The major producers were China, the United States, India, and Russia. These four leading producers accounted for about 62 percent of the total produced in 1996.

More information on this subject can be found in the following EIA publications: *Annual Energy Review; Weekly Coal Production; Coal Industry Annual; Coal Data; A Reference: Monthly Energy Review;* and *International Energy Annual.*

Coal Reserves

> *As of January 1, 1995, the DRB contained an estimated 496 billion short tons. Because of property rights, land use conflicts, and physical and environmental restrictions, some coal in the DRB may not be available and accessible for mining.*

In the United States, there are vast deposits of coal--more extensive than those of natural gas and petroleum, the other major fossil fuels. Total U.S. coal resources in the ground are estimated to be 4 trillion tons, of which 1.7 trillion tons are identified resources. Identified resources include the demonstrated reserve base (DRB), which comprises coal resources that have been mapped within specified levels of reliability and accuracy and which occur in coal beds meeting minimum criteria for thickness and depth from the surface that generally support economic mining under current technologies.

The actual proportion of minable coal resources that can be recovered economically 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. Adverse geologic features, such as folding, faulting, and interlayered rock strata, limit the amount of coal that can be recovered at some underground and surface mines. EIA's most recent estimate is that nearly 55 percent of the DRB may be recoverable. Currently, it is estimated that U.S. recoverable coal reserves total 274 billion short tons.

Coal "rank" refers to the degree of alteration or "coalification" the organic source material in coal has attained. There are four major ranks of coal in the U.S. classification scheme, from highest to lowest: anthracite, bituminous, subbituminous, 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, its agglomerating characteristics (or caking properties during combustion). Of the four ranks, bituminous coal accounts for over half (52 percent) of the DRB. 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 DRB) is west of the Mississippi River, with most of it in Montana and Wyoming. Lignite, the lowest-rank coal, accounts for about 9 percent of the DRB and is found mostly in Montana, Texas, and North Dakota. Anthracite, the highest-rank coal, makes up only 15 percent of the DRB and is concentrated almost entirely in northeastern Pennsylvania.

Current world recoverable reserves are estimated to be 1.1 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 (11 percent), Australia (9 percent), Germany (6 percent), South Africa (5 percent), and Poland (4 percent) also have significant amounts of recoverable coal reserves.

EIA obtains new information and data updates largely through its Coal Reserves Data Base program initiated in 1990. That program has encouraged the participation of State agencies in revising coal resource and reserves estimates in their respective States. Since 1990, new DRB and recoverable reserve estimates have been developed by State geological and mining agencies and EIA through cooperative agreements in Ohio, Wyoming, New Mexico, eastern Kentucky, and Illinois. These projects include improved analyses of coal quality, accessibility, and recoverability in the study areas. In addition to updating the core resource data, the result in improved estimates of the heat and sulfur content and typical net recovery of the reserves.

More information on this subject can be found in the following EIA publications: *U.S. Coal Reserves: An Update by Heat and Sulfur Content*, *Coal Data: A Reference*, *International Energy Annual*, *Coal Industry Annual*, and *Annual Energy Review*.

Electricity Capability

The United States electrical system is the largest 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 1996 was 776 gigawatts (GW). (One gigawatt is equal to 1 million kilowatts.) Of this total capability, 710 GW were owned by utilities and 66 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).

In order to meet the growing demand for electricity and to offset retirements of existing capacity, a projected 319 GW of new capacity will be needed by 2015. Of the new capacity expected to be added by utilities and nonutility producers, 81 percent is expected to be combined-cycle or combustion turbine technology fueled by natural gas or both oil and gas. Before building new capacity, utilities are expected to use other options to meet the capacity needs. These include extending the service life of many existing units, repowering of existing capacity, demand-side management, purchases of power from cogenerators, and imports of electricity from Canada and Mexico. The amount of net electricity imports and purchases from nonutilities increased over 73 percent between 1991 and 1996 from 161 billion kilowatthours (kWh) to 279 billion kWh, accounting in 1996 for 9 percent of the electricity needed by utilities to meet customer demand. Net imports from Canada and Mexico are expected to decline by 40 percent between 1994 and 2015.

Renewable energy for electricity is dominated by hydropower; however, because the best resources for hydropower have already been developed, hydropower capacity is expected to increase only slightly. The contribution of other renewable resources, such as wind, solar, geothermal, municipal solid waste, and biomass, to electricity supply is projected to increase, particularly, after 2000. Biomass is expected to lead the growth in generation from renewable fuels. The penetration of biomass in the electric generation market will depend on the price of conventional fossil fuels and the role that future environmental legislation and regulations may have in limiting fossil fuel consumption and promoting the development of renewable fuels. Wind energy is considered a well-developed renewable energy technology. Projections of low fossil fuel costs and the potentially competitive forces created by the emergence of restructured electricity markets, which tend to favor established technologies, increase the uncertainty of wind power's future. Solar thermal and photovoltaic generation are expected to enjoy modest growth between 1996 and 2015. Municipal solid waste (MSW) electricity generation is a byproduct of waste management and its growth in contribution to electricity supply is expected to be limited by environmental concerns and the use of other waste management strategies, such as recycling, composting, and landfilling. Geothermal energy is limited geographically to those areas with easily accessible high-temperature hydrothermal resources (hot water and steam).

More information on this subject can be found in the following EIA publications: *Annual Energy Outlook*, and *Electric Power Annual Volume II*.

Electricity Generation

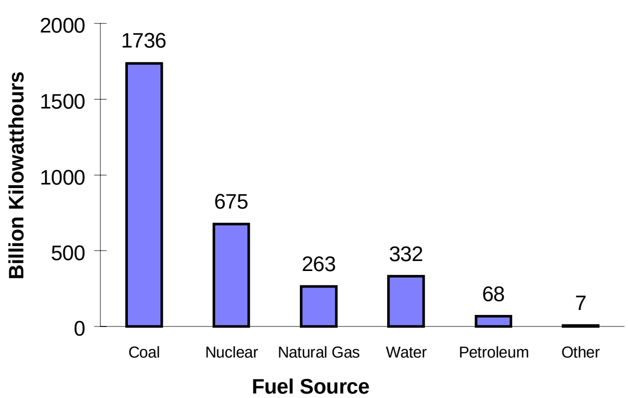
Consumers expect electricity to be available whenever they plug in an appliance, turn a switch, or open a refrigerator. Satisfying these instantaneous demands requires an uninterrupted flow of electricity. In order to meet this requirement, utilities operate several types of electric generating units, powered by different fuel sources: coal, uranium, water, natural gas, petroleum, and nonwater renewable energy sources.

Coal was the fuel used to generate the largest share (52 percent of electricity in 1996, 1,736 billion kilowatthours(kWh). [This is over one and a half times the annual electricity consumption of all U.S. households (1,078 billion kWh).] Natural gas was used to generate 307 billion kWh (10 percent), and petroleum accounted for 68 billion kWh (2 percent).

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.

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 1996, 675 billion kWh.

U.S. Net Electricity Generation, 1996



Source: Energy Information Administration,
***Annual Energy Review 1996*, DOE/EIA-0384(96).**

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 1996, hydroelectric generation had the third largest share (10 percent) of electricity production at 332 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 1996 totaled 5 billion kWh. Electric utility generation in 1996 was 3,078 billion kWh, 1 percent greater than the 1995 total of 2,995 billion kWh.

More information on this subject can be found in the following 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.

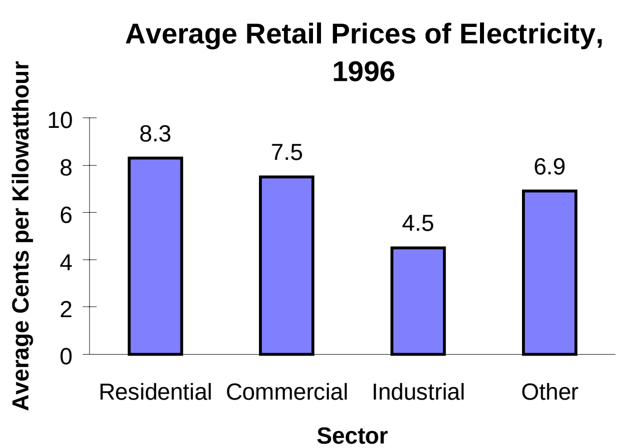
Electric utility companies charge their customers different rates, depending on the type of customer and on the customer's electricity needs. That collection of rates is called a tariff. The tariff is designed to provide the privately owned electric utility with enough income to allow investors to earn 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.

There are approximately 950 cooperative electric utilities in the United States currently doing business in 47 States. These utilities are owned by their members and are established to provide electricity to those members.

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.)

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.



Source: Energy Information Administration, *Electric Sales and Revenue 1996*, DOE/EIA-0540(96).

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 1996 (that is, the price adjusted to reflect the purchasing power of the dollar) was 20 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 can be found in the following 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 (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, transportation, and "other" which includes public street and highway lighting.

In 1996, U.S. electric utilities generated 3,079,074 gigawatthours (1 GWh=1 billion watthours) of electricity and sold an estimated 3,084,664 GWh to their consumers. This amount represents about a 2-percent increase over 1990, when total sales were about 2,704,672 GWh. In 1973, by contrast, total sales were 1,712,909 GWh.

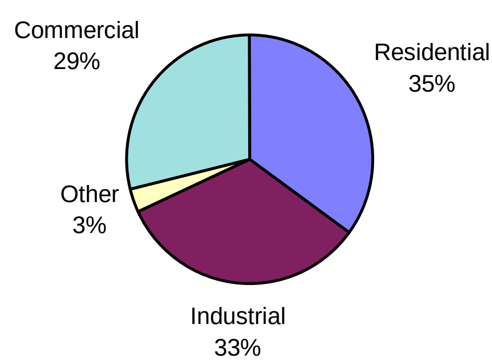
Since 1980, sales to residential consumers have been increasing at an average rate of 2 percent per year. Residential consumers, in 1996, purchased 1,078,512 GWh, an increase of 3 percent over the amount purchased the previous year. The 1996 residential sales accounted for 34 percent of total sales. Among the nine Census divisions, the South Atlantic Division had the largest annual sales to residential consumers, both in 1996 (261,433 GWh) and in 1995 (250,998 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 1995 (196,236 GWh).

Industrial consumers in 1996 purchased 33 percent of sales to consumers, or 1,014,347 GWh, about 0.1 percent more than in 1995. Other sales (public street and highway lighting, sales to public authorities, and sales to railroads and railways) were 100,217 GWh, over 3 percent of total sales to all consumers and slightly more than the amount sold for similar purposes in 1995.

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

Share of Electricity Sales, 1996--Percent



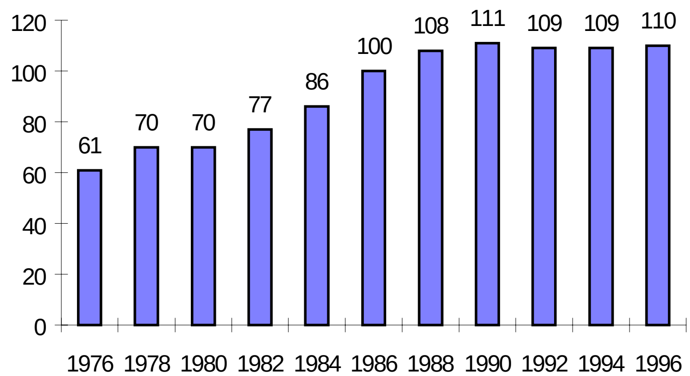
Source: Energy Information Administration, *Annual Energy Review 1996*, DOE/EIA-0384(96).

Nuclear Power Generation

Electricity has been generated by burning fossil fuels (coal, oil, and gas) since before the turn of the century. For over three decades, however, a nonfossil fuel, uranium, also has 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 1996, there were 110 units in operation that produced 675 billion net kilowatthours, or 22 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.

Operable Nuclear Units in the United States, 1976-1996



Source: Energy Information Administration, *Annual Energy Review 1996*, DOE/EIA-0384(96).

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 nation in the world; next is France, third is Japan, and fourth is Germany. Worldwide, growth in nuclear power has slowed and this trend is expected to continue. While no nuclear reactors have been ordered in the U.S. since 1978, several countries, notably France, Japan, and South Korea, continue to have ambitious nuclear construction programs. Concerns about issues such as high-level waste disposal, decommissioning expenses when reactors are retired, and the use of nuclear reactors to relieve possible global warming associated with fossil fuel-based generation will influence the future level of growth of nuclear power worldwide.

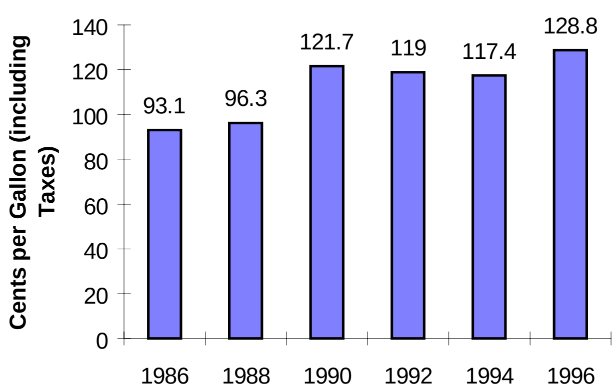
More information on this subject may be found in the EIA publications: *Annual Energy Review* and *Nuclear Power Generation and Fuel Cycle Report.*

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. refineries (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. 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 Soviet Union, the world's leading oil producer. In 1990, as a result of the Persian Gulf crisis, the average cost of crude oil rose to $22.22 per barrel. Prices have declined steadily since then. The yearly average cost of petroleum in 1996 was $20.66 per barrel. This was due to the relatively weak world demand for petroleum, overproduction of crude oil by the Organization of Petroleum Exporting Countries (OPEC)*, abundant world inventories, and continued improvements in global energy efficiencies.

Motor gasoline constitutes about half of the total volume of products produced from crude oil. Retail motor gasoline prices generally follow the same pattern as crude oil prices; however, prices fluctuate widely based on supply and demand conditions. Data from 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 motor gasoline.

Motor Gasoline Prices at the Pump, All types, 1986 - 1996



Source: Energy Information Administration, *Annual Energy Review* 1996, DOE/EIA 0384(96).

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 1970s initiatives aimed at reducing emissions. By 1990, leaded motor gasoline represented only 5 percent of total motor gasoline sales and had been replaced almost entirely by unleaded motor gasoline. Refining processes have been changing in order to produce high octane unleaded motor gasoline, and in response to tighter restrictions on motor gasoline volatility (RVP), which became effective in 1989. Oxygenates, such as methyl tertiary butyl ether (MTBE), and gasoline set forth in the Clean Air Act Amendments of 1990 (CAAA) will make these additives increasingly important in the future.

* OPEC comprises oil-producing and exporting countries that have organized for the purpose of negotiating with oil companies on matters of oil production, prices, and future concession rights. Algeria, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela are OPEC member countries. Prior to January 1, 1993, Ecuador was a member of OPEC.

The CAAA also imposed new requirements on producers, transporters, and suppliers of distillate fuel oil. Those requirements included standards for fuels designated for on-highway use of a maximum sulfur content of 0.05 percent by weight and a minimum cetane level of 40. Further, these fuels must also be colorless to clearly designate them for use on-highway use. Other diesel or distillate fuels will be dyed blue. The restrictions were designed to combat emissions of sulfur oxides and to assure the ignition performance of the diesel fuel meets the American Society for Testing and Materials standards for combustion. The CAAA standard took effect October 1, 1993, and affects about 46 percent of the total domestic demand for distillate fuel, or about 9 percent of total U.S. petroleum demand.

Distillate fuel oil is a general classification for one of the petroleum fractions produced in conventional distillation operations. It is used primarily for space heating, on- and off-highway diesel engine fuel, and electric power generation.

No. 2 distillate includes No. 2 fuel oil and No. 2 diesel fuel. Currently these products are physically similar; however, No. 2 diesel fuel intended for use in passenger cars 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.

The average U.S. sales price of No. 2 fuel oil sold to residential consumers for heating was 119.4 cents per gallon in 1981, then declined to 80.3 cents per gallon in 1987, and rebounded to 106.3 cents per gallon in 1990, then declined to 86.7 cents per gallon in 1995, and rebounded again in 1996 to 98.9 cents per gallon. The price data for No. 2 diesel fuel are for sales through company-operated retail outlets, include low sulfur diesel fuel only, and do not include taxes. 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 71.1 cents per gallon in 1993, and to 67.3 cents per gallon in 1994. 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. The average price was 39.2 cents per gallon in 1995.

In the late 1970s, 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 this subject can be found in the following EIA publications: *Monthly Energy Review, Annual Energy Review, Petroleum Marketing Monthly, Petroleum Marketing Annual,* and *Weekly Petroleum Status Report.*

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, a malodorous yellow-to-black liquid, is usually found in underground reservoirs. Drilling a well to extract crude oil is a complicated process, but it 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 is constructed.
A derrick is a tall structure above the hole which houses tools and pipes that go into the well. When completed, the drilled well will be turned into a production facility capable of bringing a steady flow of oil to the surface.

In 1996, total domestic crude oil field production averaged 6,465,000 barrels per day, a decrease of 95,000 barrels per day from the 1995 average. The top crude oil-producing States are Texas, Alaska, California, Louisiana, and Oklahoma.

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.

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.

Crude oil is measured in barrels. 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. In 1996, for example, one barrel of crude oil, when refined, yielded 19.19 gallons of finished motor gasoline among other petroleum products.

The United States and the former Soviet Union, along with the Organization of Petroleum Exporting Countries (OPEC),* accounted for 64 percent of the total crude oil produced in the world in 1994. The United States accounted for 11 percent of the world's total 1994 crude oil production, as did the former Soviet Union.

*OPEC comprises oil-producing and exporting countries that have organized for the purpose of negotiating with oil companies on matters of oil production, prices, and future concession rights. Algeria, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela are OPEC member countries. Prior to January 1, 1993, Ecuador was a member of OPEC.

Petroleum Products Yielded from
One Barrel of Crude, 1996

Product	Gallons
Finished Motor Gas	19.19
Distillate Fuel Oil	9.53
Kero-Type Jet Fuel	4.37
Residual Fuel Oil	2.10
Still Gas	1.89
Petroleum Coke	1.89
Liquefied Refinery Gas	1.89
Asphalt and Road Oil	1.30
Petrochemical Feedstocks	1.13
Lubricants	0.50
Special Naphthas	0.17
Kerosene	0.17
Naphtha-Type Jet Fuel	
Miscellaneous Products	0.13
Finished Aviation Gasoline	0.08
Waxes	0.08
Total	44.35

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

Petroleum Product Consumption

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.

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.

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-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.

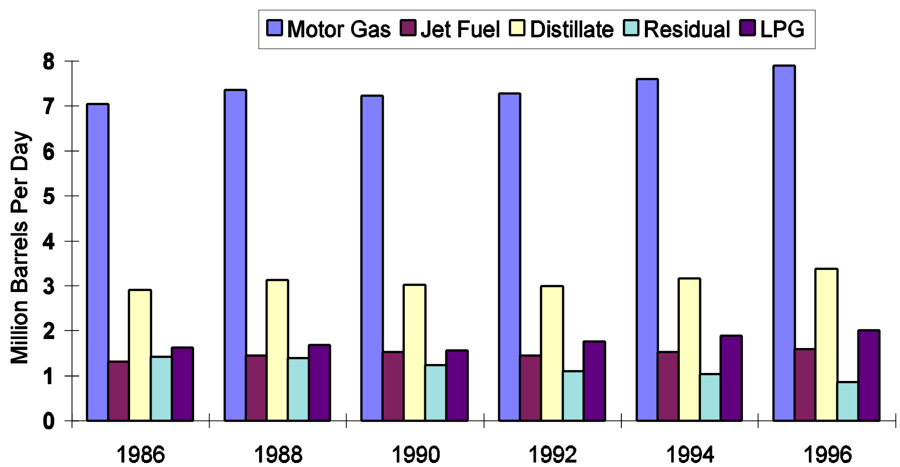
In 1996, total U.S. demand for petroleum was 18.2 million barrels per day, of which 8.4 million barrels per day, or 46.2 percent, was from net imports (imports minus exports). Falling crude oil prices, high refinery runs and declining domestic crude oil production resulted in this highest import dependency level since 1977. 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 growth in imports was due largely to 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.

Did you know that motor gasoline is the petroleum industry's principal refined product? A record 7.9 million barrels per day were consumed in 1996.

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 1996 was 3.37 million barrels per day, nearly matching the 1978 high of 3.43 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 1996 of 0.8 million barrels per day, a 73 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. In 1995, the three countries that consumed the most petroleum products were the United States (17.7 million barrels per day), Japan (5.7 million barrels per day), and China (3.3 million barrels per day).

Petroleum Products Consumption in the United States, 1986-1996



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

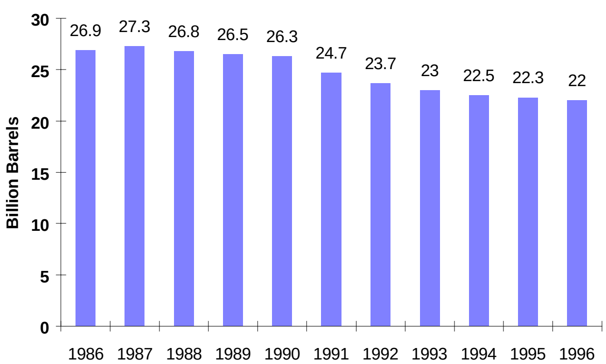
More information on this subject can be found in the following EIA publications: *Monthly Energy Review*, *Annual Energy Review*, *Petroleum Marketing Monthly*, and *International Energy Annual.*

Petroleum Reserves

> *Offshore refers to that geographic area that lies seaward of the coastline. In general, the coastline is the line of ordinary low water along with that portion of the coast that is in direct contact with the open sea or the line making the seaward limit of inland water.*

Proved reserves of crude oil are the estimated quantities that geological and engineering data demonstrate, with responsible 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 1996, are 22.0 billion barrels, a 1-percent decrease from that of 1995 (Figure 4). Thirty-one States have crude oil reserves. The top five are Texas, with 5.7 billion barrels; Alaska, with 5.3 billion barrels; California, with 3.4 billion barrels; New Mexico, with 744 million barrels; and Oklahoma, with 632 million barrel. In addition, there are substantial crude oil reserves in the Federal Offshore fields: 2.6 billion barrels in the Gulf of Mexico and 518 million barrels in the Pacific.

U.S. Crude Oil Proved Reserves, 1986-1996



Source: Energy Information Administration, *U.S. Crude Oil, Natural Gas and Natural Gas Liquids Reserves 1996 Annual Report,* **DOE/EIA-0216(96).**

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: (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 one 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 1996, there were 565.8 million barrels of crude oil in the Reserve.

More information on this subject can be found in the following 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 $C_3 H_8$ 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.

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 94 million households in the United States, 8.2 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 peak shaving 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, half of which is produced at natural gas processing plants, and half at petroleum refineries. Import levels for 1996 totaled 44 million barrels while U.S. exports of propane were 10 million barrels. (A barrel contains 42 gallons.)

In December 1996, nationwide primary stocks--stocks held at refineries, bulk terminals, gas processing plants, and pipelines--were at 46 million barrels. During the warmer months, however, inventories can be as high as 52 million barrels--as seen in September 1996--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 1996's refiner propane prices to end users which, excluding taxes, began the year at almost 72 cents per gallon, declined to 56 cents per gallon in June, and then rose to about 93 cents per gallon by December.

More information on this subject can be found in the following EIA publications: *Winter Fuels Report, Petroleum Supply Monthly, Petroleum Supply Annual, Petroleum Marketing Monthly, Petroleum Marketing Annual, The Value of Underground Storage in Today's Natural Gas Industry,* and *An Analysis of U.S. Propane Markets, Winter 1996-1997.*

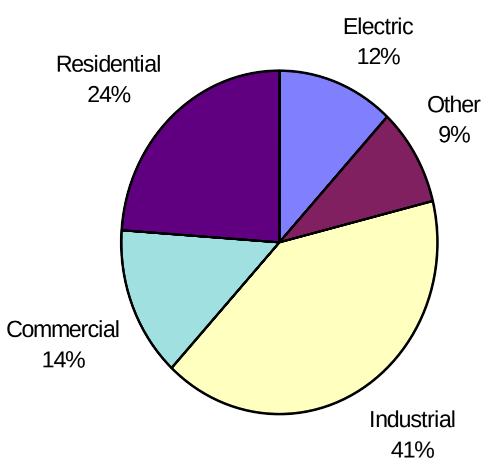
Natural Gas Consumption

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.

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.

In 1996, U.S. natural gas consumption was over 22 trillion cubic feet (Tcf), which was about 25 percent of all U.S. energy consumption. Industrial sector consumption was 8.9 Tcf, or 40 percent of total gas consumption. Residential sector consumption was 5.2 Tcf, 24 percent of the total, and commercial sector consumption was 3.2 Tcf, 14 percent. Electric utilities, which burned 2.7 Tcf of gas to generate electricity, accounted for 12 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 2015, U.S. natural gas consumption is projected to range between 26 Tcf and 31 Tcf, with most of the increase being used for electricity generation.

Natural Gas Consumption
1996 - Percent



Source: Energy Information Administration, *Natural Gas Monthly,* DOE/EIA-0130.

In 1996, world natural gas consumption was 82.2 Tcf. Russia, which consumed 14.5 Tcf, and the United States, which consumed 21.9 Tcf, accounted for 48 percent of the total. By the year 2010, total world consumption is expected to range between 99 Tcf and 116 Tcf.

More information on this subject can be found in the following 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 widely accepted theory about how natural gas was created is that it was formed by the underground decomposition of organic matter (dead plants and animals). If the organic matter is buried deeply enough, much of the carbon and hydrogen is converted to methane, the major component of natural gas. (The chemical formula for methane is CH_4--that is, a molecule of methane has one carbon atom and four hydrogen atoms.) Large volumes of methane can be trapped in the subsurface of the Earth at places 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. Produced natural gas placed in temporary underground storage is not included in proved reserves.

"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 hydrocarbon.

As of December 31, 1996, the estimated U.S. total proved reserves, wet after lease separation, were 175,147 billion cubic feet (Bcf). Of that quantity, non-associated gas (natural gas not in contact with significant quantities of crude oil) accounted for 144,352 Bcf. The remaining natural gas occurred with crude oil, either as free gas (associated) or in solution (dissolved), and accounted for 30,795 Bcf. Estimated proved reserves of dry natural gas in the United States were 166,474 Bcf. (Dry natural gas is the volume of natural gas that remains after the economically liquefiable hydrocarbon portion has been removed from the produced gas stream at a natural gas processing plant.) Dry natural gas reserves increased 1 percent in 1996, a gain of 1,328 Bcf. Coalbed methane accounted for over 6 percent of reserves and 5 percent of production in 1996.

In addition to proved natural gas reserves, there 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 gas resources are located in the Alaska and Gulf Coast regions. Over one-third of all undiscovered gas resources are estimated to be in Federal offshore areas, primarily near Alaska, in the Gulf of Mexico, and along the Atlantic Coast.

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

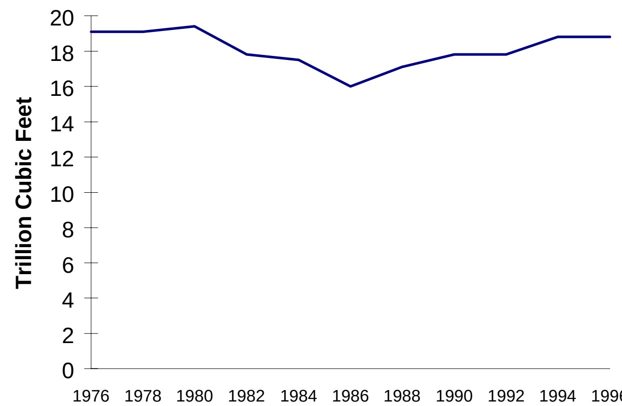
Natural Gas Supply

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 1996, dry natural gas production accounted for 29 percent of total U.S. energy production and was produced from over 301,000 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 8.8 trillion cubic feet (Tcf), Texas led all States with 6.1 Tcf, followed by Louisiana with 5.1 Tcf, Oklahoma with 1.6 Tcf, and New Mexico with 1.4 Tcf.

After reaching a peak of 21.7 Tcf in 1973, U.S. production declined as low as 16.1 Tcf in 1986. Since then, production has steadily increased. By the year 2015, production is expected to range between 22.5 Tcf and 26.8 Tcf.

U.S. Dry Natural Gas Production, 1976-1996 (Trillion Cubic Feet)



Source: Energy Information Administration, *Monthly Energy Review,* **DOE/EIA-0035(96/04).**

In addition to natural gas production, the U.S. gas supply is augmented by imports, by withdrawals from storage, and by supplemental gaseous fuels. Imports of natural gas in 1996 totaled 2.9 Tcf, or over 13 percent of total U.S. consumption. The vast majority of these imports arrive from Canada via pipeline. Gas imported from Algeria and the United Arab Emirates, 40 billion cubic feet (Bcf) in 1996, 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 is then transported to the United States on specially designed ships.

There were 406 active storage fields in the United States during 1996. Natural gas is injected into these fields generally during April through October and withdrawn during November through March. The volume of gas available for withdrawal ranges from near 3 Tcf at the end of October to under 1 Tcf at the end of March.

Supplemental gas supplies, which in 1996 totaled 109 Bcf, include blast furnace gas, 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 1996 produced 56 Bcf of gas from coal.

World production of natural gas is dominated by the United States and Russia, whose combined production account for 49 percent of the 78 Tcf produced in 1996.

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

Residential Uses of Energy

In 1993, U.S. households spent an average of $1,282 on energy (electricity, natural gas, liquid petroleum gas, fuel, and kerosene) used in the home. This ranged from $991 for households with an annual income less than $5,000 to $1,809 for households with an annual income of $75,000 or more. By geographic location, the average amount households spent on energy was: Northeast, $1,526; Midwest $1,336; South $1,304; and West, $953.

In 1993, the national average amount households spent on end uses was: for space heating $410, for air conditioning $117; for water heating, $176; for refrigerators $124; and for appliances, $455. Space-heating expenditures ranged from $250 in the West to $585 in the Northeast and air conditioning expenditures ranged from $45 in the West to $212 in the South. The average expenditures for water heating, refrigerator and appliances were relatively constant among the four regions.

In 1993, U.S. households spent more money on electricity than all other fuels combined. Households spent an average of $840 on electricity and $442 on other fuels. In "all-electric" homes, households spent an average of $1,145 on electricity, whereas in homes heated with natural gas, households spent an average of $703 on electricity and $591 on other fuels, including natural gas. ("All-electric" homes tend to be smaller and newer than homes heated with natural gas and are more likely to be in the South.)

In 1993, almost all households had some way of heating their home but 0.9 percent of the homes had no space heating. (Many of these are in Hawaii.)

In 1993, 66 percent of the homes (66.1 million out of 99.6 million) contained some form of air-conditioning equipment. Central air-conditioners were in 42 percent of the homes and an additional 24 percent contained window/room air conditioners. Among the occupants of the 66.1 million homes with air-conditioning equipment, 36.1 percent reported using the equipment "all summer," 22.2 percent reported using it "quite a bit," 38.3 percent reported using it "a few times," and 3.4 percent reported that they did not use their air conditioning equipment at all.

In 1993, almost all households had at least one refrigerator (99.8 percent) and 14.9 percent of the households had two or more refrigerators. Almost all households had at least one color television set (97.7 percent) and 20.7 percent had 3 or more.

More information on this subject can be found in the EIA publication *Household Energy Consumption and Expenditures 1993.*

Renewable Energy

Fossil fuels are finite, with known domestic supplies projected to last no more than another 10 generations. On the other hand, renewable energy sources - water (hydropower), biomass, wind, heat from the earth (geothermal) and the sun (solar energy) - can be sustained. "Green" renewables contribute much less to global warming. and climate change by offsetting fossil fuels used to generate electricity.

The use of renewable energy is not new. Five generations (125 years) ago, wood supplied up to 90 percent of our energy needs. Due to the convenience and low prices of fossil fuels, wood use has fallen. Now, the biomass which would normally present a disposal problem is converted into electricity (e.g., manufacturing wastes, rice hulls, and black liquor from paper production).

Currently, low fossil fuel prices, especially for natural gas, make growth difficult for renewable fuels. The deregulation and restructuring of the electric power industry could have a major impact on renewable energy consumption. Demands for cheaper power in the short term would likely decrease demand for renewable energy, while preferences for renewables included in some versions of proposed electricity restructuring legislation would breathe new life into this industry.
Use of renewables in the United States is not currently expected to approach that of the major fuels, and due to their limitations (e.g., their intermittent nature - cloudy days, no wind blowing, land availability, dams are primarily for flood control; hydroelectricity production varies as dams' water levels change) renewables may never provide "the" answer to all energy problems. Under some conditions, renewable energy is proving to be of great value, especially overseas.

The sun produces a nearly constant flow of energy that can be converted to other energy forms, such as electricity and heat, or stored in biomass. Clouds, the daily pattern of light and darkness, seasons, and dust in the air greatly affect the fraction of sunlight which is available. The sun's rays have to fall on a relatively large area for enough heat to be collected for conversion to electricity; a "concentrating collector" can be used to focus the rays onto a much smaller area.

Solar energy can also be converted into electricity by means of a photovoltaic cell (based on the element silicon). Photovoltaic systems generate electricity which may be used for lighting and appliances, stored in batteries, or in a one-person automobile. In nations with underdeveloped electricity networks, photovoltaic systems have been chosen because of their flexibility.

The major economic application of solar energy is heating residences and other buildings. Solar collectors, often seen on rooftops, are used for hot water, space heating and heating swimming pools. However, backup heating systems are generally needed.

Windpower is actually solar-based energy because wind results from the sun's heating the earth in a non-uniform manner. From 1880 to 1930, more than six million wind turbines generated electricity or pumped water in the United States. With electricity delivery systems across the nation being powered by cheaper fossil fuels, these were no longer needed. Electricity from modern windpower has been demonstrated using technologically advanced wind turbine designs. Steady, fairly high winds (12+ miles per hour), without lulls and high gusts, are needed for commercial electricity generation. Such conditions occur in many places in the United States.

Biomass, formed when the sun shines on plants and trees, can be burned, providing heat for homes and fuel for boilers. Electricity generators burn wood chips, sawdust, garbage, bagasse (a plant refuse), and low-quality methane gases from landfills - but this is limited by distance to the generator from the available supply (roughly 35 miles - distance increases costs and decreases profits), and by the mass which would be removed from the topsoil (a form of erosion). Corn is converted to alcohol (ethanol) and used to replace automobile fuel (by blending with gasoline) while soybeans have oil extracted and blended with diesel. Biomass burning for cooking and heating in underdeveloped nations may contribute to global warming and erosion.

Geothermal energy comes from natural processes beneath the earth's surface, and is recovered as steam and hot water. Known geothermal resource areas are rare, with the current domestic potential being around 27,400 megawatts (MW). (Current total national electric generating capability from all fuel sources is about 770,000 MW). Roughly 11 percent of this geothermal resource is being used for electricity generation. Most domestic electricity from geothermal energy is generated in California (the world's largest geothermal facility is at The Geysers), the other far western States, and Hawaii. Direct-use of geothermal energy for aquaculture, health spas and district heating continues to grow, as do installations of geothermal heat pumps.

More information can be found in the following EIA publications: *Renewable Energy Annual; Annual Energy Review; Monthly Energy Review; and the Electric Power Annual.*

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."

> *Technically, a degree-day is a 1-degree F difference between 65 degrees F and the mean outdoor air temperature on a given 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. 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.

EIA provides information about degree-days in its publication *Monthly Energy Review*. 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 on the next page show that, in the Middle Atlantic States, January 1996 was colder than January 1995 (Table 3). In January 1996, 1,166 heating degree-days were recorded, up from 961 degree-days (warmer than normal) in January 1995. On the other hand, the Mountain States were cooler in January 1995 (881 heating degree-days) than in January 1996 (942 heating degree-days).

The data show that, on average, the United States was warmer in January 1995 than in January 1996, and warmer than normal in 1995. The National Oceanic and Atmospheric Administration (NOAA) is another source of information about degree-days for the country as a whole.

More information on this subject can be found in the EIA publication *Monthly Energy Review*.

Heating Degree-Days by Census Division

Census Division	January 1 through January 31					Cumulative July 1 through January 31				
				Percent Change					Percent Change	
	Normal[a]	1995	1996	Normal to 1995	1995 to 1996	Normaa[b]	1995	1996	Normal to 1996	1995 to 1996
New England Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	1,110	1,184	931	-16.1	-21.4	2,439	2,601	2,522	3.4	-3.0
Middle Atlantic New Jersey, New York, Pennsylvania	1,012	1,112	863	-14.7	-22.4	2,131	2,258	2,158	1.3	-4.4
East North Central Illinois, Indiana, Michigan, Ohio, Wisconsin	1,143	1,210	1,068	-6.6	-11.7	2,402	2,668	2,580	7.4	-3.3
West North Central Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota	1,247	1,224	1,282	2.8	4.7	2,596	2,747	2,895	11.5	5.4
South Atlantic Delaware, Florida, Georgia, Maryland and the District of Columbia, North Carolina, South Caroline, Virginia, West Virginia	571	648	510	-10.7	-21..3	1,084	1,252	1,137	4.9	-9.2
East South Central Alabama, Kentucky, Mississippi, Tennessee	718	766	619	-13.8	-19.2	1,380	1,588	1,398	1.3	-12.0
West South Central Arkansas, Louisiana, Oklahoma, Texas	523	498	443	-15.3	-11.0	877	895	847	-3.4	-5.4
Mountain Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	950	846	867	-8.7	2.5	2,145	1,956	2,120	-1.2	8.4
Pacific[b] California, Oregon, Washington	564	488	506	-10.3	3.7	1,227	1,077	1,252	2.0	16.2
U.S. Average[b]	**836**	**862**	**755**	**-9.7**	**-12.4**	**1,724**	**1,819**	**1,794**	**4.1**	**-1.4**

[a] "Normal" is based on calculations of data from 1961 through 1990.
[b]Excludes Alaska and Hawaii.
Sources: There are several degree-day databases maintained by the National Oceanic and Atmspoheric Administration. The information published here is developed by the National Weather Service Climate Analysis Center, Camp Springs, MD. The data are available weekly with monthly summaries and are based on mean daily temperatures recorded at about 200 major weather stations around the country. The data provided here are available sooner than the Historical Climatology Series 5-1 (heating degree-days) and 5-2 (cooling degree-days) developed by the National Climatic Center, Federal Building, Asheville, NC, 28801, which compiles data from some 8,000 weather stations.

More information on this subject can be found in the EIA publication *Monthly Energy Review.*