Oklahoma's Energy Landscape

Photo courtesy Fred Marvel, Oklahoma Tourism Board

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Introduction

Due to its tremendous impact on so many aspects of American life, from the economy to national security, energy resources continue to come under close scrutiny. Much of this scrutiny is a result of our dependence on fossil fuels—dominantly oil and natural gas—in a country where exploration for these natural resources has taken place for nearly 150 years (see Glossary of Terms for definitions). This "maturity" of the U.S. oil and gas industry, which is mirrored in Oklahoma (Figure 1), means that the areas available (both geologically and politically) for hydrocarbon exploration harbor little potential for significant discoveries. This translates into an increasing inability by the U.S. to replace the oil and gas volumes consumed, and explains the corresponding increase in our dependence on imports.

This tight domestic supply picture is aggravated by dramatic increases in energy demand. In the last 50 years alone, U.S. overall energy consumption has increased approximately 200%. As can be seen in Figure 2, energy consumption in the United States continues to grow astronomically, with the fossil fuels of petroleum, natural gas, and coal accounting for the vast majority of this energy usage. American self-sufficiency ended in the late 1950s, and the disparity between total energy production and consumption continues to widen (Figure 3). On a Btu basis, coal exports are more than offset by imports of natural gas and petroleum (Figure 4). Today, 15% of natural gas and more than 50% of America's petroleum needs are supplied by imports. Among the nation's top energy sources, only the demand for coal can be met from exclusively domestic sources. In 1999, U.S. coal production was 1.10 billion tons, while consumption was 1.04 billion tons (Energy Information Administration, 2001a).

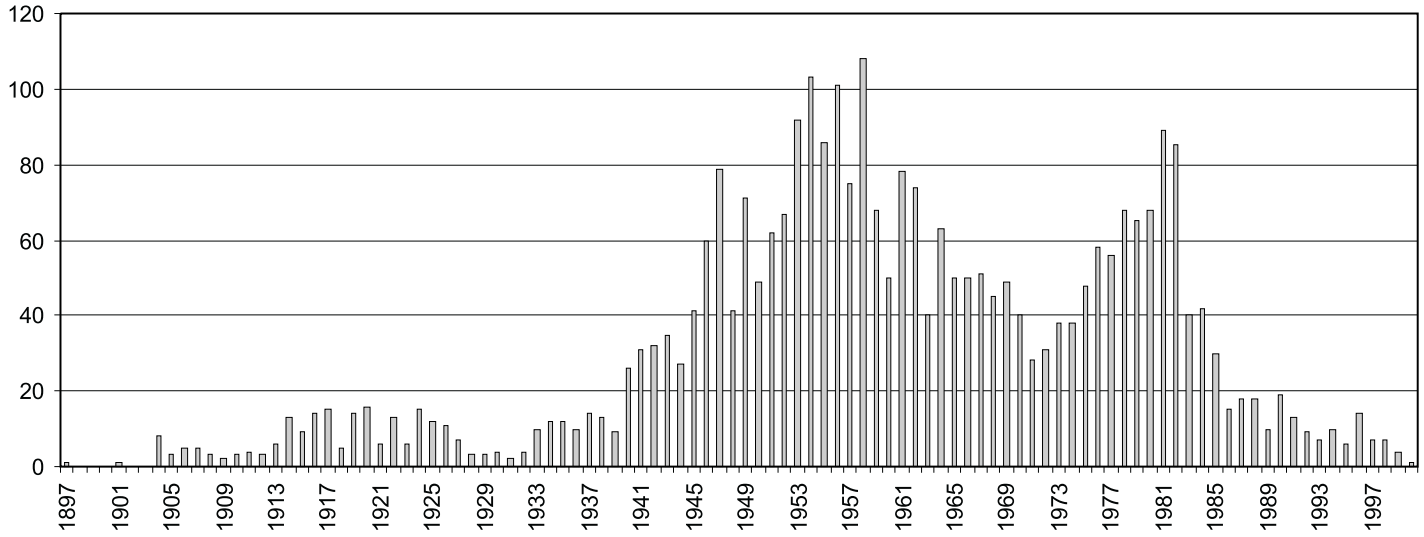


Figure 1. Oklahoma active field discovery dates by year, 1897–2000. Data from Natural Resources Information System (NRIS) (accessed July 2001).

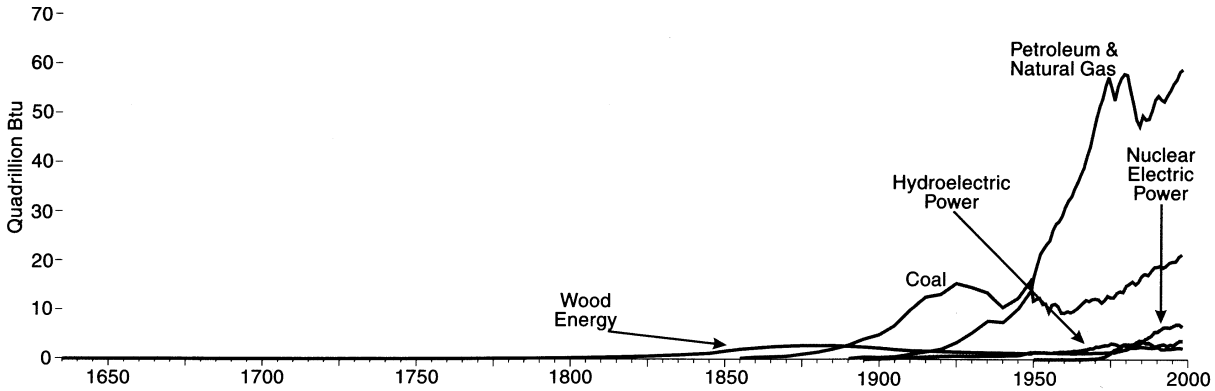


Figure 2. Energy consumption from different sources in the United States from 1635 through 1998. From Energy Information Administration (1999a, fig. 1).

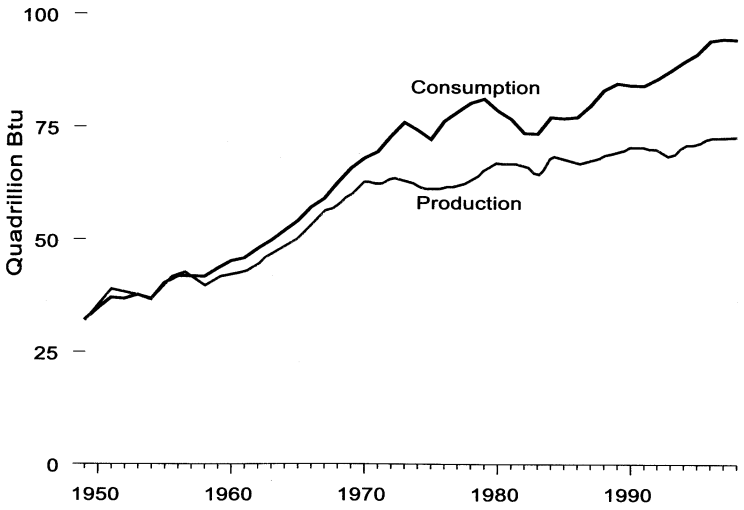


Figure 3. United States energy production and consumption from 1948 through 1998. From Energy Information Administration (1999a, fig. 3).

Oklahoma Fossil Fuels

Oil production began in Oklahoma almost 100 years ago, with a daily rate at statehood (1907) of 121,000 barrels, making it the largest oil producing entity in the world. Oklahoma's peak production rate of 762,000 barrels per day was reached in 1927 (Figure 5). Although the Statewide rate has declined in mid-2001 to approximately 180,000 barrels per day, even this reduced volume at current prices (approximately $25/bbl) has a value of about $1,640,000,000 (1.64 billion dollars) per year. It is well known that oil prices are highly volatile (Figure 6), with the peak annual price for Oklahoma crude being seen at $35.18/bbl in 1981. This contrasts sharply with the 21-year low reached in 1998, when crude sold for an average of $13.12/bbl.

Today's oil production is roughly equal to the rate seen in 1913, and it is part of a generally continuous decline that began in 1967 (Figure 5). While the drilling boom in the late 1970s and early 1980s temporarily reversed this trend, by the late 1980s the original rate of decline was firmly reestablished. Today the bulk of the State's oil production comes from low-rate (less than 10 barrels of oil per day) "stripper" wells located in fields that have been producing for decades. Because of the large number of wells in the oil-producing and potentially oil-producing regions of the State, it is unlikely that the overall decline in oil production will change significantly. Oklahoma currently ranks fifth nationally in crude oil production.

Although natural gas production in Oklahoma began in 1906, gas tended to be seen as a drilling hazard and not as an objective for hydrocarbon exploration through most of the first half of the 20th century. This, combined with the fact that from a geological standpoint the State has always been more gas- than oil-prone, is why the Oklahoma gas industry continues to exhibit considerable potential. Peak gas production in Oklahoma was reached in 1990 at a rate of approximately 6.2 billion cubic feet (BCF) per day (Figure 7). Current production is about 4.4 BCF/day, which translates at $3 per thousand cubic feet, to a value of nearly $5,000,000,000 (5 billion dollars) per year. Historic U.S. natural gas prices are shown in Figure 8.

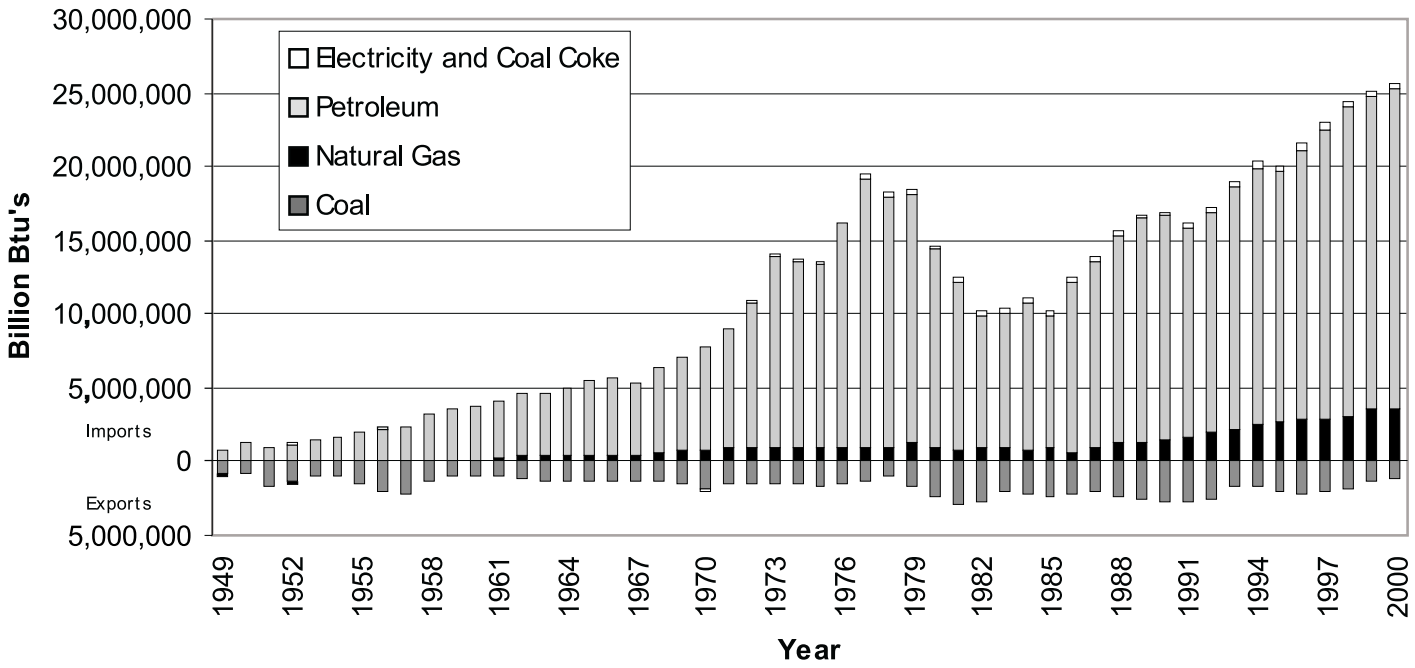


Figure 4. United States net energy imports from 1949 through 2000. Data from Energy Information Administration (2001b, table 1.4).

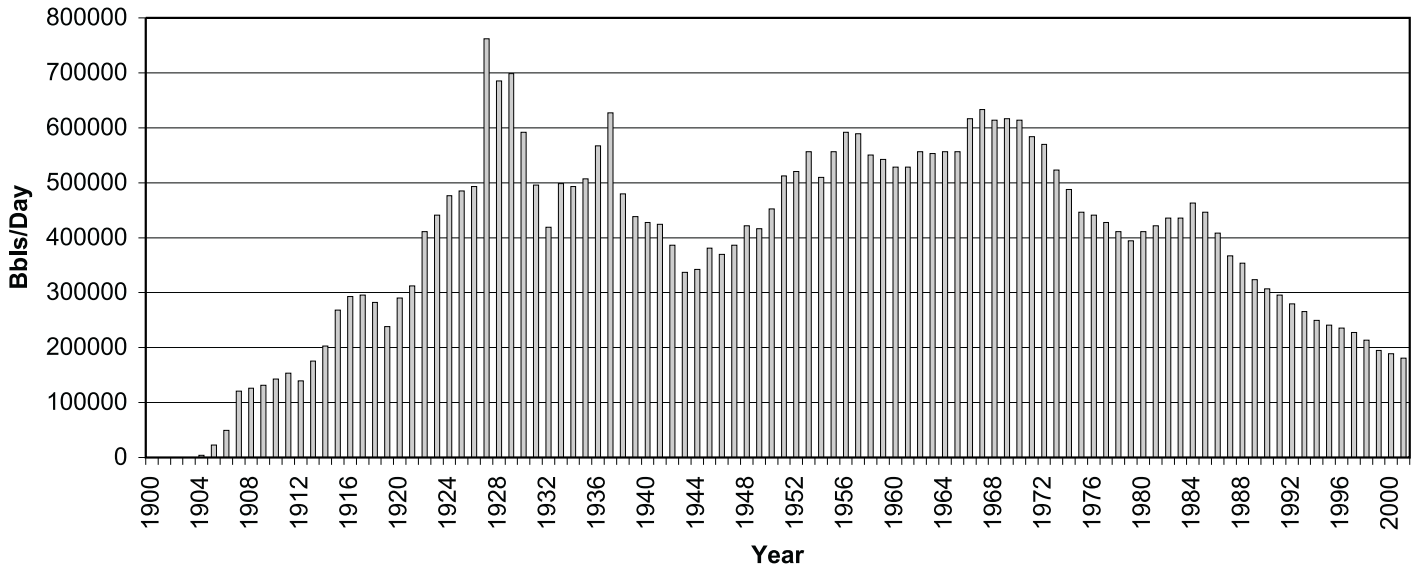


Figure 5. Oklahoma oil production from 1900 through 2001 (projected). Data from Oklahoma Corporation Commission (accessed July 2001).

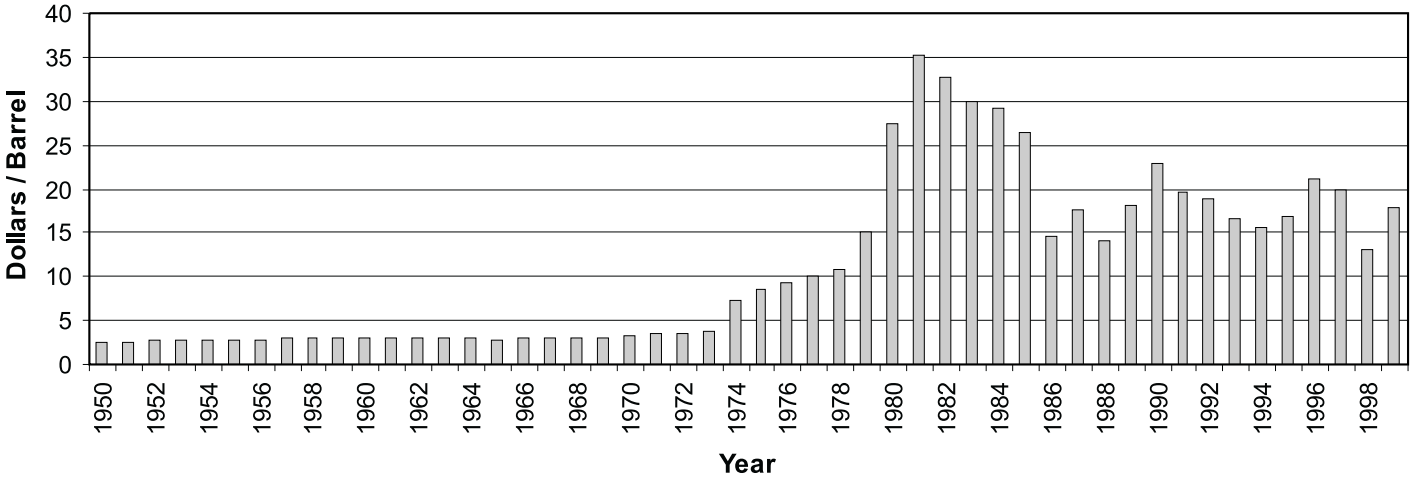


Figure 6. Average Oklahoma crude oil price from 1950 through 1999 (in non-inflation adjusted dollars). Data from Oklahoma Corporation Commission (accessed July 2001).

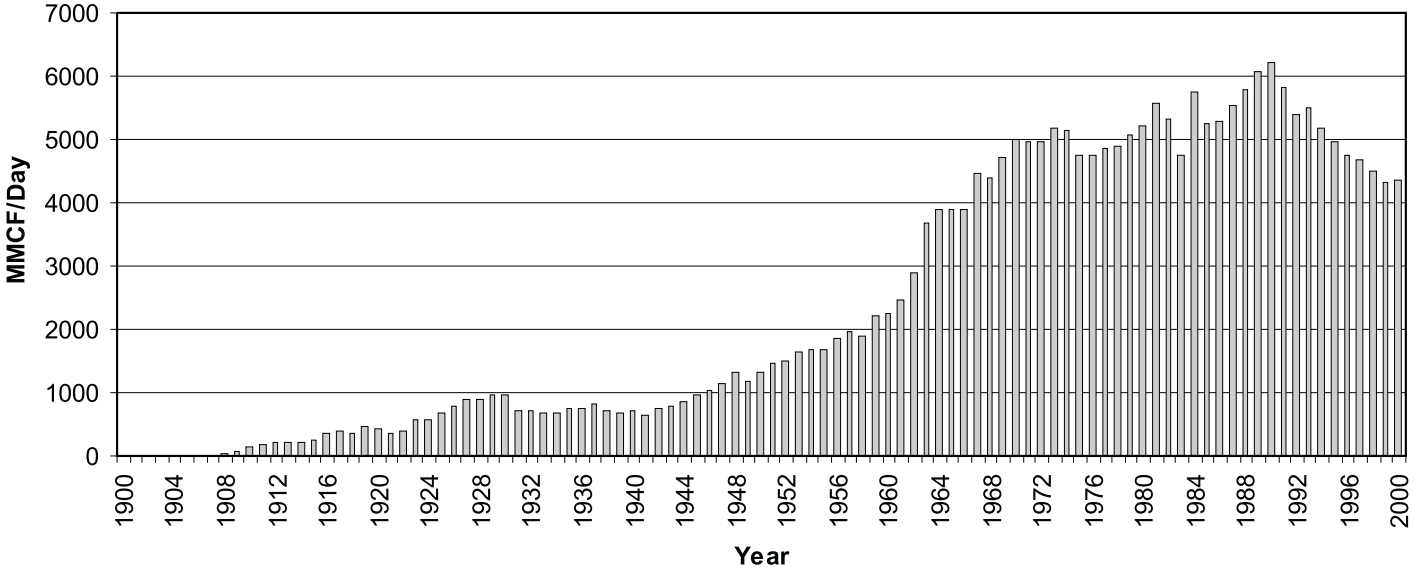


Figure 7. Oklahoma natural gas production from 1900 through 2000. Data from Oklahoma Corporation Commission (accessed July 2001).

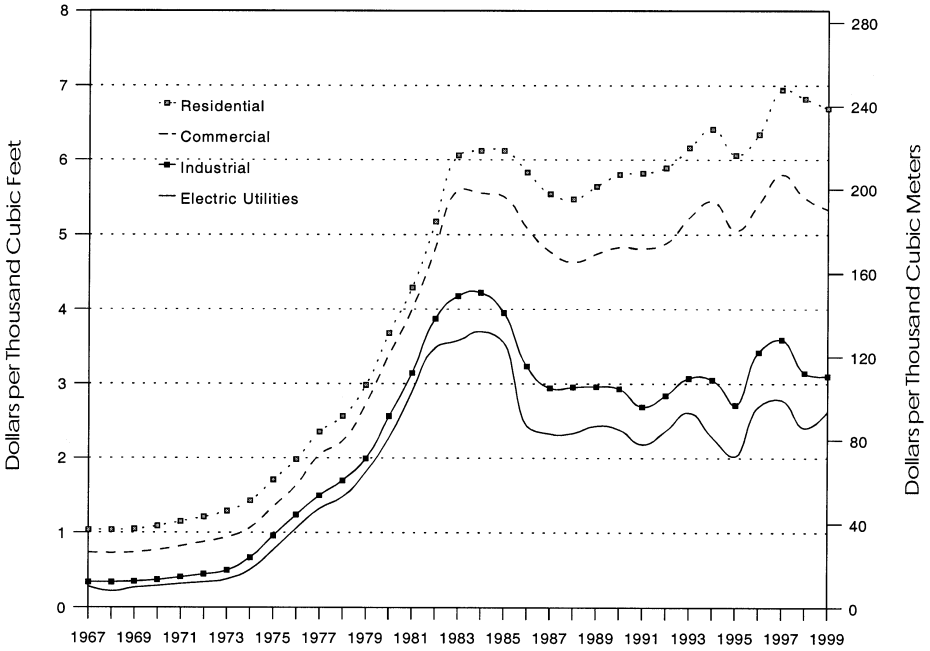


Figure 8. Average delivered natural gas price to U.S. consumers from 1967 through 1999 (in non-inflation adjusted dollars). From Energy Information Administration (2001c, fig. 24).

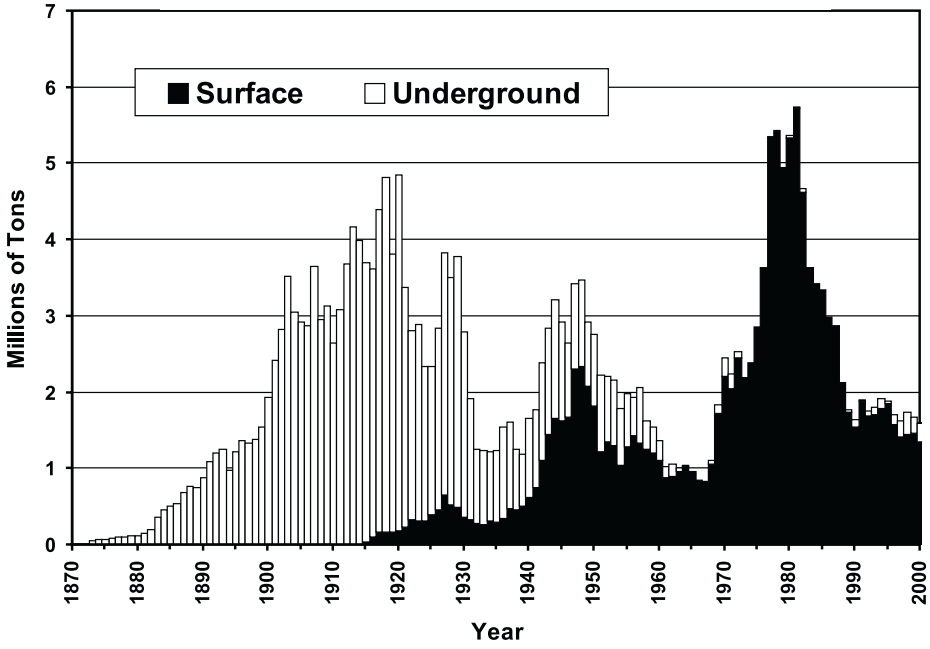


Figure 9. Coal production in Oklahoma from 1873 through 2000. Data adapted from Oklahoma Department of Mines (2000), U.S. Bureau of Mines (1950, 1933), Eavenson (1942), and U.S. Geological Survey (1926).

Oklahoma currently ranks second, behind Texas, in U.S. natural gas production, and slightly ahead of Louisiana (#3) and New Mexico (#4). Drilling activity in the State today, especially exploratory drilling, is dominated by wells with gas objectives. This makes it likely that natural gas production in the State will remain strong well into the 21st century. However, because economics are always the primary driving force, this forecast presupposes that the industry will not be adversely affected by a repetition of the price reduction seen in the late 1980s and early 1990s (Figure 8). If such an event does not occur, the potential exists to maintain or even increase natural gas production in both the short and medium term.

Bituminous coal was first produced in Oklahoma from underground mines in 1873 following the westward expansion of railroads (Figure 9). Surface mines were not introduced until 1915. Following production highs reached during the two World Wars, peak Statewide coal-production of 5.73 million tons was attained in 1981. Current production is about 1.6 million tons, with a value of approximately $42,500,000 (42.5 million dollars). Oklahoma contains 8.09 billion tons of identified coal resources in an area of approximately 8,000 square miles. Located entirely in eastern Oklahoma, approximately 813 million tons are estimated to be reserves. Oklahoma ranks 21st of 26 U.S. states in coal-production and 19th of 32 states in coal reserves.

Oklahoma Energy Consumption

Oklahoma has been a net energy exporter since statehood. This fortunate circumstance is the result of a relatively modest population/industrial base combined with the geologic good fortune of encompassing the bulk of the prolific Anadarko, Ardmore, and Arkoma basins and

related producing provinces (Figure 10). Energy consumption in Oklahoma has paralleled U.S. growth trends with overall demand more than doubling since 1960 (Figures 3 and 11). Fossil fuels (natural gas, petroleum, and coal) account for nearly all of the energy consumption in the State, with the contributions made by wood/waste and hydroelectric energy generation being relatively insignificant. Oklahoma possesses no nuclear energy industry. Of note is the fact that reductions in the use of natural gas have been offset largely through an increased reliance on coal (Figure 11).

Petroleum products represent about 35% of energy consumption in Oklahoma and include a variety of products, among them gasoline, lubricants, LPG (liquefied petroleum gas), aviation fuel, asphalt, and road oil. Gasoline is the most significant product, with approximately 44 million barrels consumed per year. This equates to an average Statewide consumption of more than 5,000,000 gallons per day. Total petroleum products consumption in the State is currently about 95 million barrels per year. Comparing this to a Statewide crude oil production of approximately 65 million barrels per year, one can see that even in a premier producing state such as Oklahoma, demand still far outpaces supply.

The supply/demand balance is much better for natural gas. In-state gas consumption is about half a trillion cubic feet (0.5 TCF) per year, mostly by factories (industrial) and electric utilities (Figure 12). In contrast to oil, Oklahoma produces about three times as much gas as it consumes (Figure 13). This surplus today is about one trillion cubic feet per year, a volume that is worth over three billion dollars. As can be seen in Figure 14, the gas supply in the U.S. as a whole was able to keep pace with demand through 1987. Since then more gas has been consumed than produced, and this disparity continues to increase rapidly. Based on such long-term consumption trends, there is no doubt that the U.S. market can absorb as much natural gas as Oklahoma is able to export.

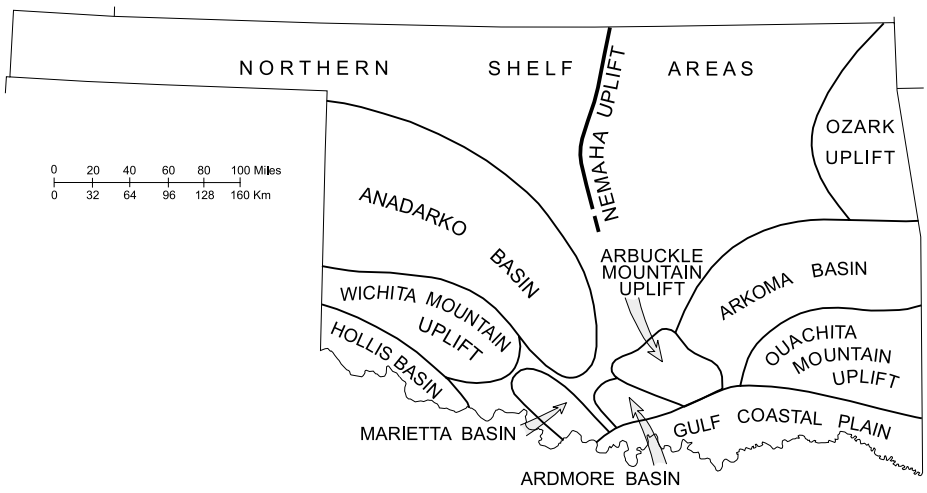


Figure 10. Geologic provinces of Oklahoma. Modified from Johnson and others (1972).

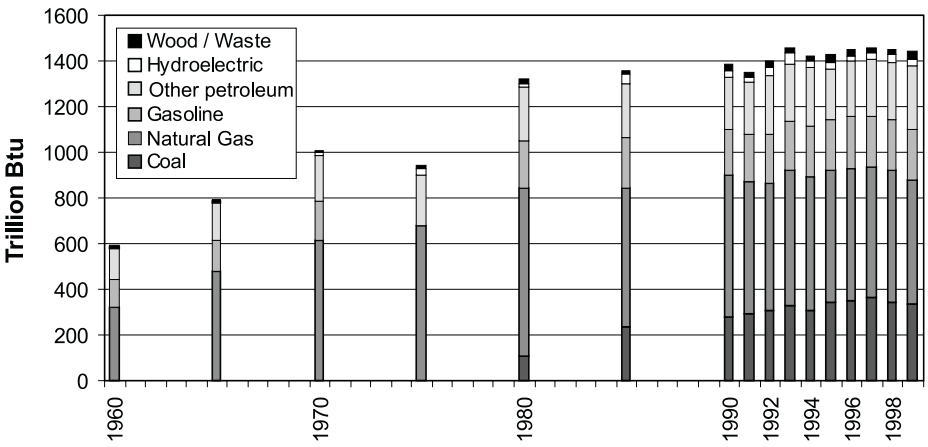


Figure 11. Oklahoma energy consumption by source, 1960–1999. Data from Energy Information Administration (2001d, table 233).

Oklahoma coal has a relatively high sulfur content. In order to meet strict sulfur emission requirements at coal-fired power plants, Oklahoma has imported low-sulfur subbituminous coal, mostly from Wyoming, since 1980. Most coal consumed in Oklahoma takes place at these coal-fired power plants, with lesser amounts being utilized at cement/lime kilns and a paper plant (Figure 15). The oldest coal-fired power plants in Oklahoma were placed on-line in 1978. The five main public-utility plants consumed about 20 million tons of imported Wyoming coal in 1999. The AES Shady Point facility located in Le Flore County is a non-

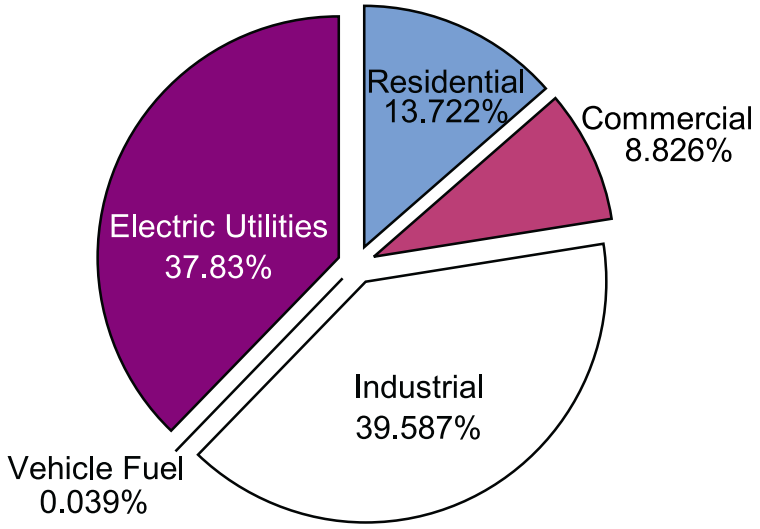


Figure 12. Oklahoma natural gas consumption, 1999. Data from Energy Information Administration (2001d, table 77).

utility power plant that in 1999 used about one million tons of Oklahoma's high-sulfur bituminous coal. AES utilizes an advanced coal-combustion technology that results in low sulfur dioxide and nitrogen oxide emissions.

Oklahoma Electricity Generation

Electricity in Oklahoma is generated in a variety of ways, and Figure 16 illustrates the total generation capacity of the State by energy source. With such a large surplus of Oklahoma natural gas, its 54% share of the capacity pie is easy to understand. However, utility companies are publicly owned businesses and must produce electricity as economically as possible. This means favoring a less expensive fuel source where possible. In this case, because of its consistently lower cost per Btu relative to petroleum or natural gas, the fuel of choice is coal (Figure 17). To put these three fossil fuels into perspective, one pound of bituminous coal, 14 cubic feet of gas, and one-tenth of a gallon of fuel oil have approximately equal Btu values. Assuming equal heating efficiencies in electricity generation, each of these would be able to provide enough electricity to light ten 100-watt light bulbs for one hour. At current prices the fuel cost to the utility to light these ten bulbs for one hour would be about 1.3 cents for coal, 4.2 cents for gas, and 6.0 cents for fuel oil.

The locations of the major electrical utility power plants in Oklahoma are shown in Figure 18. To keep transmission losses down, which for electricity can be quite large, these tend to be concentrated near population centers. In terms of where electricity originates, utility companies account for about 94% of the electrical generation in the State. In addition to a number of much smaller municipal authorities, the largest utilities are #1—Oklahoma Gas and Electric Company and #2—Public Service Company of Oklahoma. To put their relative size in perspective, OG&E is 50% larger than PSO, which is 18 times larger than the next largest Oklahoma utility company. The service areas for OG&E and PSO are shown in Figure 19. The primary energy sources used by utility companies to generate electricity in Oklahoma are fuel oil, hydroelectric, natural gas, and coal.

Fuel oil fired and hydroelectric plants account for a small proportion of the State's electricity picture, representing 8% of the total capacity and 7% of the generation. Only three very small plants in the northern portion of the State have fuel oil as a primary energy source, and most of these typically run on less expensive

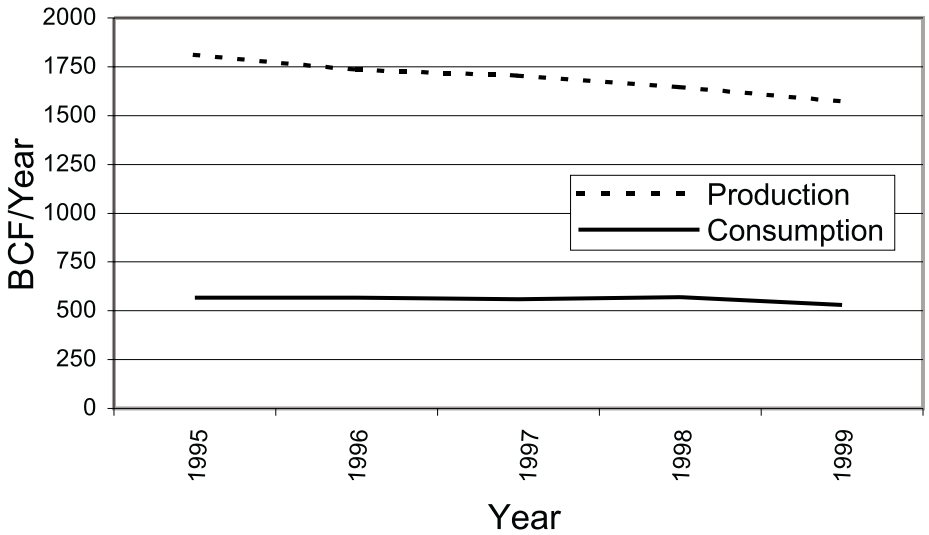


Figure 13. Oklahoma natural gas production and consumption from 1995 through 1999. Data from Energy Information Administration (2001d, table 77).

natural gas. These facilities are the oldest as a group, and have an average initial start-up date of 1952, which falls within the era of high oil production for the State (Figure 3). Hydroelectric power plants have been built in association with many of the dams that were constructed in the eastern portion of Oklahoma. These small- to medium-sized plants were built during a major period of dam building and have an average start-up date of 1962. Unlike fossil-fuel-fired power plants, hydroelectric plants utilize the force of falling water to generate electricity, and so are dependent on water availability, which is a function of local rainfall.

The most common type of electric utility power plant in Oklahoma is the gas-fired, and these account for one third of the State's electrical generation. There are 77 of these plants scattered throughout the State, ranging in capacity from less than 50 to more than 1,000 megawatts. The smaller non-utility power plants, which account for 6.5% of State capacity, are also dominantly gas-fired. While the average start-up date for the utility-owned facilities is 1963, many of these were converted from plants that initially used fuel oil as

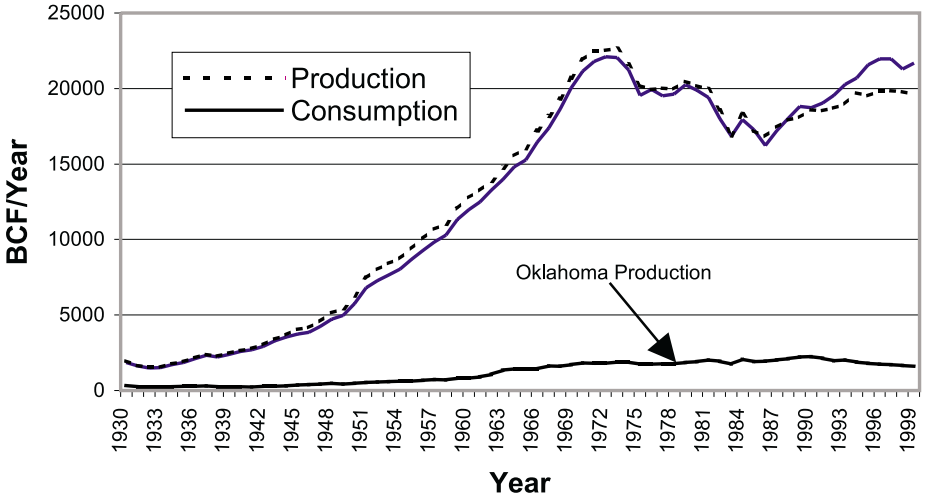
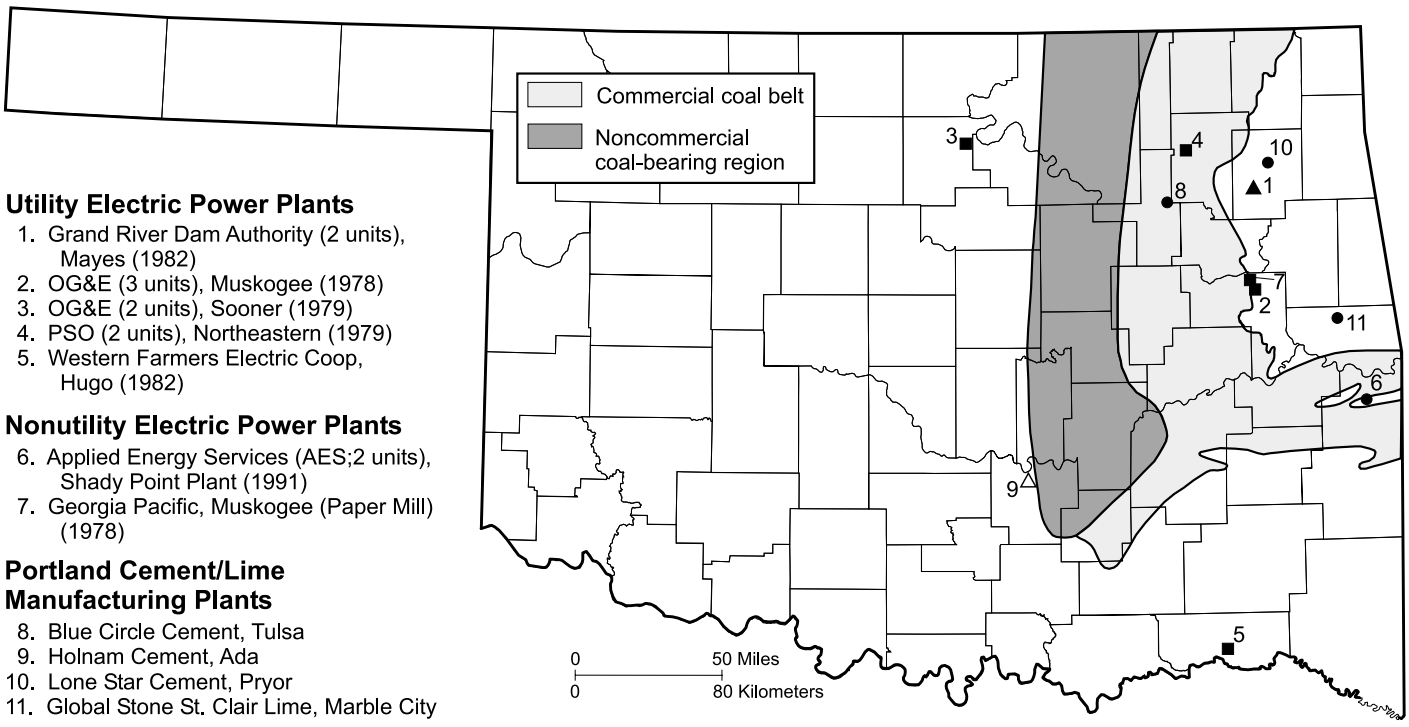


Figure 14. United States natural gas production and consumption from 1930 through 1999. Data from Energy Information Administration (2001c, tables 92 and 93).



Utility Electric Power Plants

1. Grand River Dam Authority (2 units), Mayes (1982)
2. OG&E (3 units), Muskogee (1978)
3. OG&E (2 units), Sooner (1979)
4. PSO (2 units), Northeastern (1979)
5. Western Farmers Electric Coop, Hugo (1982)

Nonutility Electric Power Plants

6. Applied Energy Services (AES;2 units), Shady Point Plant (1991)
7. Georgia Pacific, Muskogee (Paper Mill) (1978)

Portland Cement/Lime Manufacturing Plants

8. Blue Circle Cement, Tulsa
9. Holnam Cement, Ada
10. Lone Star Cement, Pryor
11. Global Stone St. Clair Lime, Marble City

Figure 15. Map of coal consumers in Oklahoma. Index map showing company name, year commercial operation began, and location of major consumers in Oklahoma of Wyoming coal (■), Oklahoma coal (●), Wyoming/Oklahoma coal blend (▲), and coal source from other states (Δ). Data from Energy Information Administration (2000a, table 20; 1999b, table 8) and Sanda (2000).

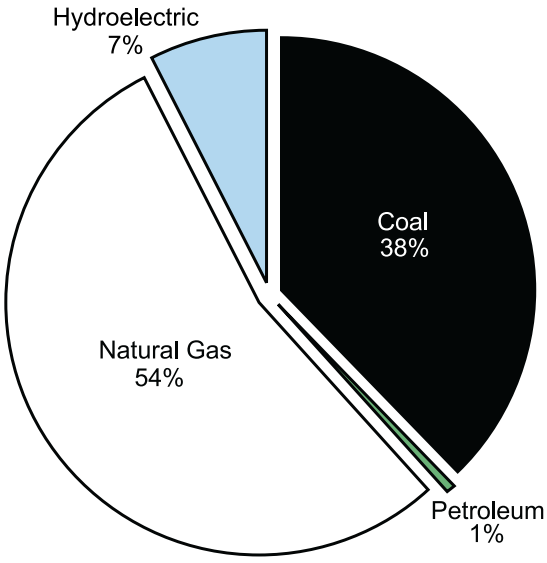


Figure 16. Oklahoma utility electricity generating capacity by primary energy source, 1999. Data from Energy Information Administration (2000b, table 17).

their primary energy source. Should the need arise, many of these dual-fired power plants are still capable of using fuel oil as an alternative energy source.

Coal-fired power plants account for 60% of electricity generation in the State and have an average start-up date of 1980. This corresponds to the period of time when Middle East oil supply disruptions forced a rethinking of the United States energy policy, and legislation was enacted that prohibited the use of natural gas as a boiler fuel. The coal-fired plants, located mostly near the coal fields in northeastern Oklahoma (Figure 15), tend to be relatively large, with four of the five plants having a capacity of more than 1,000 megawatts. In addition, these plants typically are run at or near maximum capacity, primarily because it is cheaper to produce a Btu with coal than it is with natural gas. This higher utilization increases coal's share of the actual generation load, with much of the more expensive gas-fired capacity used only during peak-demand periods. Figure 20 is a schematic that describes how coal is converted into electricity in a typical coal-fired power plant.

The importance of coal to actual electricity generation in Oklahoma is shown in Figure 21. Because the State's utility-run plants have excess capacity, the coal-fired plants are run at higher utilization rates than those fueled by other energy sources. Fuel oil, being the most expensive energy source, makes essentially no contribution to electricity generation in Oklahoma. Many of the State's power plants also have the ability to use more than one fuel source. Natural gas, in addition to being the primary fuel for the majority of Oklahoma's electricity generators, is also the secondary fuel of choice in the majority of the dual-fired plants. Natural gas is used because, in addition to being less expensive than fuel oil, it is readily available in a state that produces three times what it consumes.

Oklahoma's overall electricity usage grew 28% between 1988 and 1998, with residential, commercial, and industrial uses being about the same (Figure 22). This is an annual increase of about 2.5%, which is similar to other areas of the developed world for the same time period. Disregarding variable fuel costs and transmission losses, Oklahoma should be able to continue to meet the State's electricity needs well into the future. The amount of electricity

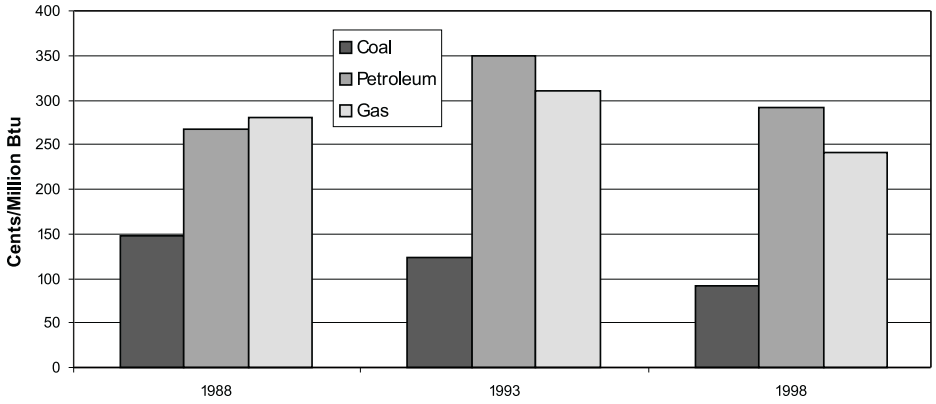


Figure 17. Fuel prices paid by utilities in Oklahoma, 1998. Data from Energy Information Administration (2000b, table 6).

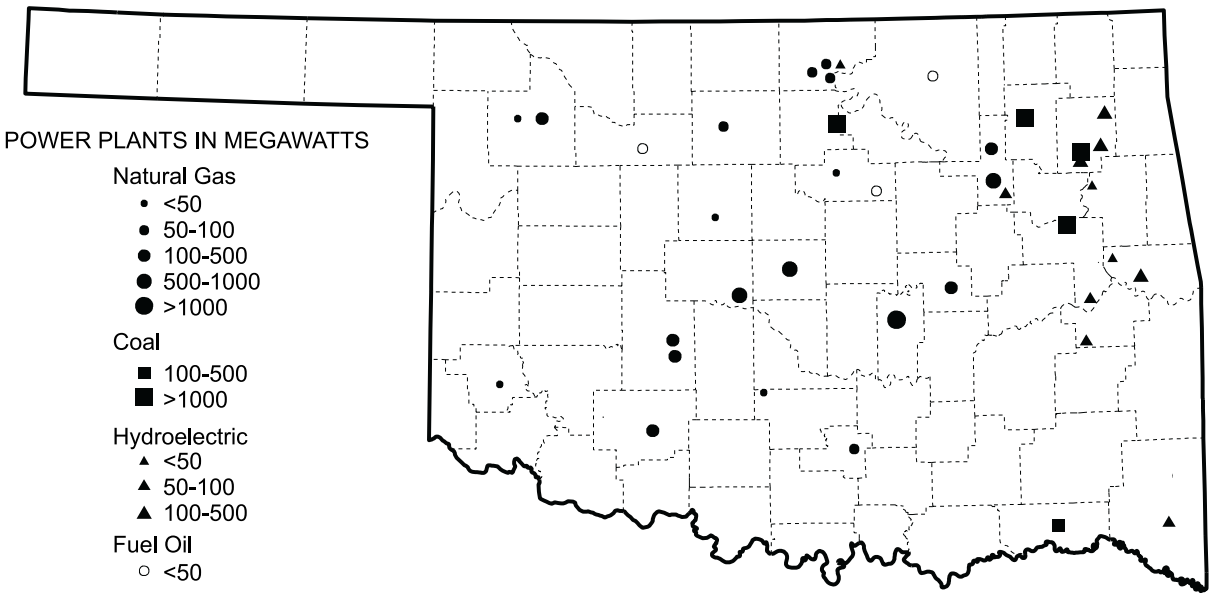


Figure 18. Map of existing electric utility power plants in Oklahoma, 1999. Data from Energy Information Administration (2000a, table 20).

generated is significantly below the maximum capacity of the plants operating in the State. While much of the excess capacity is in older, less efficient natural-gas-fired units, this should still provide a significant safety net for a gas-rich state should other fuels become unavailable. This overcapacity has permitted generation to keep pace with demand and has consistently permitted the export of excess electrical power. Export volumes are shown graphically from 1960 through 1999 in Figure 23. The average annual level of net electricity exports for Oklahoma in the ten years from 1990 to 1999 was 14 billion kilowatt-hours.

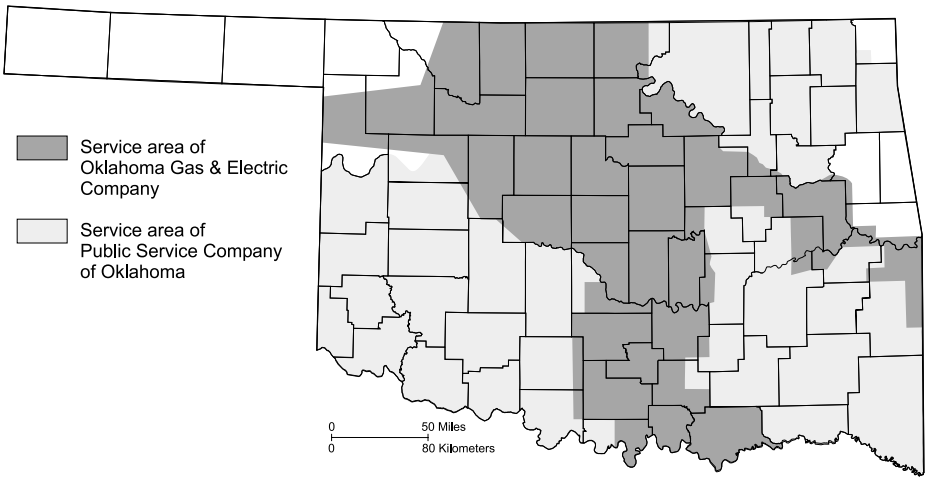


Figure 19. Map of the service areas of OG&E and PSO electric utilities. Data from Energy Information Administration (2000b) and Motley (1998).

Conclusions

Figure 24 summarizes Oklahoma's energy picture, where energy consumption and export are shown between 1960 and 1999. Consumption, which has risen almost continuously, is all-inclusive and takes into account wood/waste and fossil fuels, as well as electricity generated from both imported and local-source fuels. The State's energy exports consist of both electricity and natural gas. Electricity export has been relatively small, but steady, throughout this period of time. The much larger volumes of exported natural gas have declined significantly since 1990; a trend that parallels the State's declining productive capacity. Offsetting export volumes are petroleum imports and the electricity that is generated from imported coal. In 1999 imported petroleum products accounted for approximately 8% of the State's energy mix. In addition, for the same year, imported coal from Wyoming represented about 19% of the energy consumed in the State. Thus, based on the most recent data

available, imports account for 27% of Oklahoma's energy consumption.

While the overall declines in oil and gas production are not continuous, as seen in the slight increase from 1999 to 2000 in gas production, the days of peak production in Oklahoma are clearly in the past. In spite of this, the overall energy picture for the State is remarkably bright. On one hand, roughly one quarter of the State's energy usage is derived from imported coal and petroleum. However, this is more than offset by the export of approximately one trillion cubic feet of natural gas and smaller volumes of electricity that have a combined value of more than $3 billion per year. On a Btu equivalency, this exported gas and electricity represents about 45% of the State's total energy budget, both internally and externally generated. With the resulting 18% cushion between imports and exports, and disregarding the inevitable price fluctuations, Oklahoma should remain in a relatively strong position in energy availability for the foreseeable future.

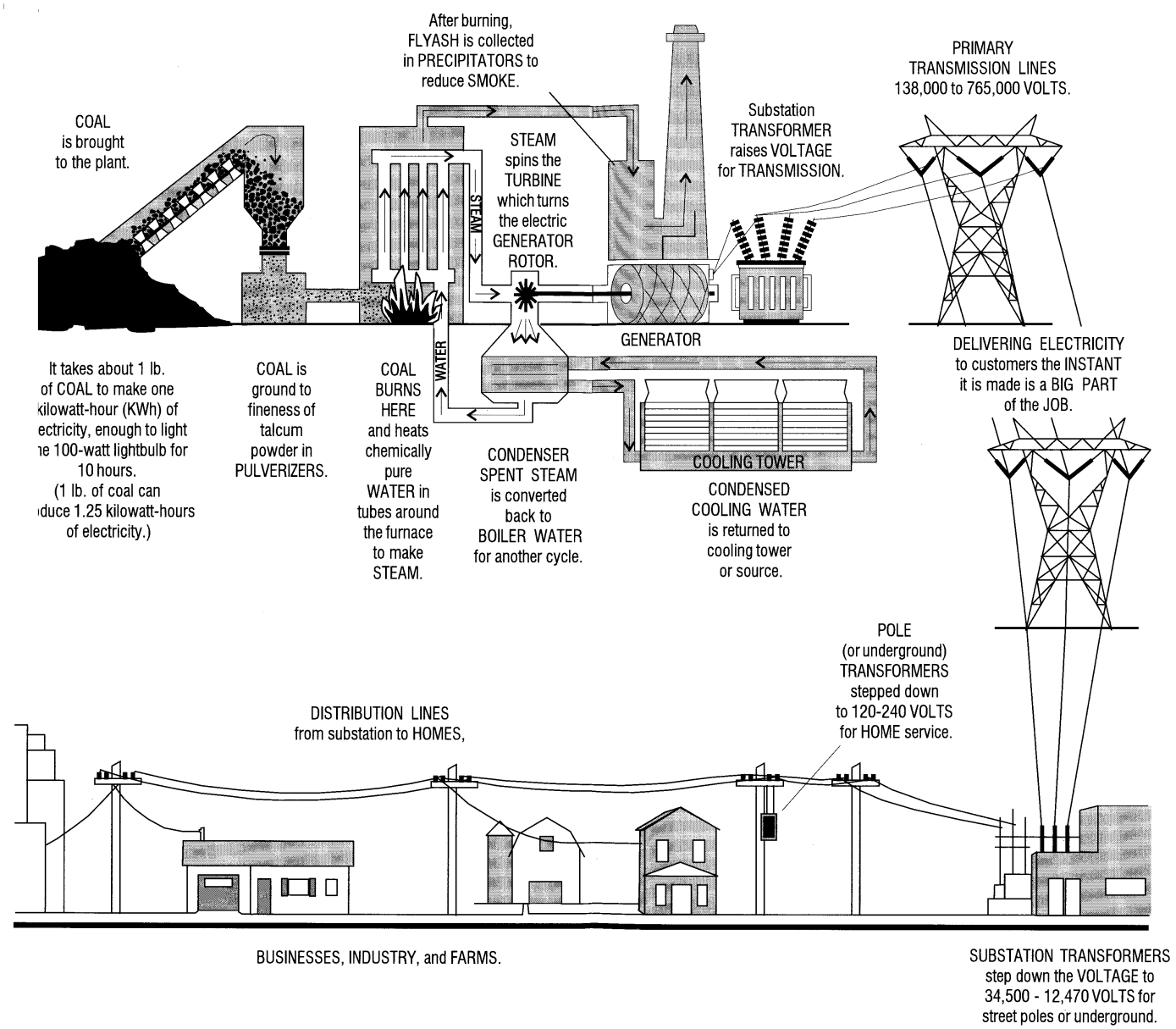


Figure 20. Diagram of the conversion of coal into electricity. From Kentucky Coal Council/Kentucky Coal Association (1999).

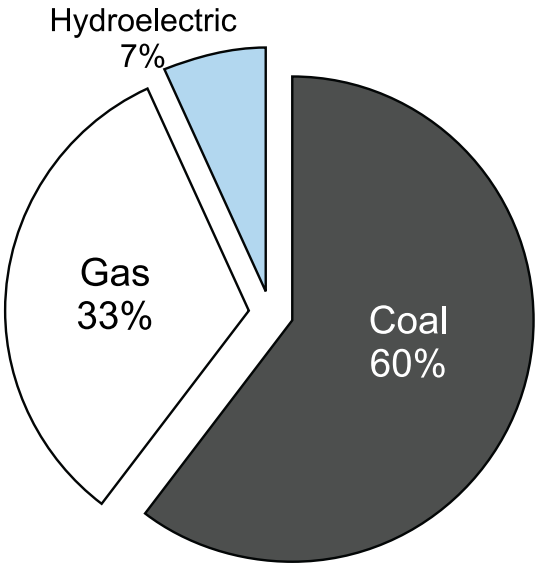


Figure 21. Oklahoma utility electricity generation by primary energy source, 1998. Data from Energy Information Administration (2000b, table 5).

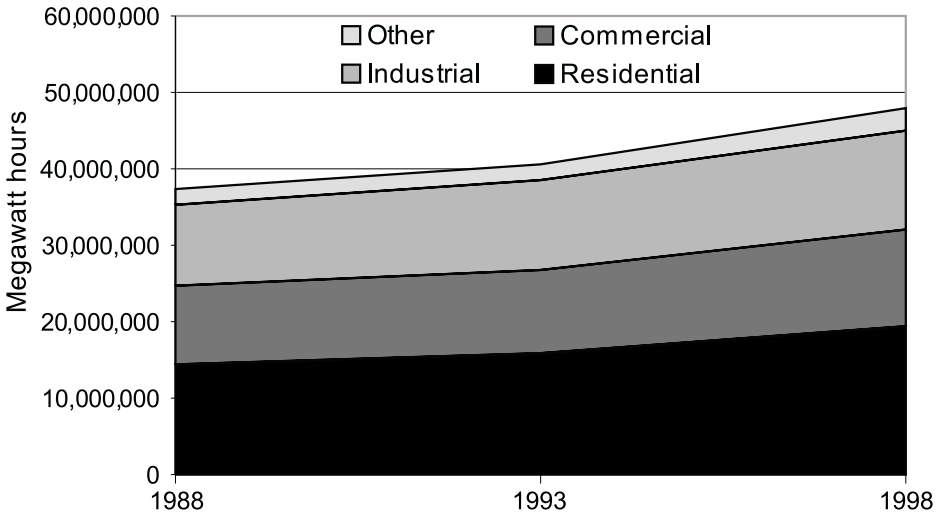


Figure 22. Oklahoma retail electricity sales by user. Data from Energy Information Administration (2000b, table 8).

Acknowledgments

The data utilized in this article came primarily from the Energy Information Administration (EIA) of the United States Department of Energy. For further information, visit the EIA web site: www.eia.doe.gov.

Sources of Information

Eavenson, H. N., 1942, The first century and a quarter of American coal industry: Privately printed, Pittsburgh, Pennsylvania, p. 568.

Energy Information Administration, 1999a, Annual energy review 1998: U.S. Department of Energy DOE/EIA-0384(98), p. xvii, xix.

————1999b, Inventory of nonutility electric power plants in the United States 1998: U.S. Department of Energy DOE/EIA-0095(98)/2, p. 108 (available on the Web at: http://www.eia.doe.gov/cneaf/electricity/ipp/ipp_sum2.html).

————2000a, Inventory of electric utility power plants in the United States 1999: U.S. Department of Energy DOE/EIA-0095(99)/1, p. 32, 157–160 (available on the Web at: http://www.eia.doe.gov/cneaf/electricity/ipp/ipp99_sum.html).

————2000b, State electricity profiles: U.S. Department of Energy DOE/EIA-0629, p. 219–223 (available on the Web at: http://www.eia.doe.gov/bookshelf/state.html).

————2001a, Coal industry annual 1999: U.S. Department of Energy DOE/EIA-0584(99), p. ix (available on the Web at: http://www.eia.doe.gov/cneaf/coal/cia/cia_sum.html).

————2001b, Annual energy review 2000: U.S. Department of Energy DOE/EIA-0384(00) (available on the Web at: http://www.eia.doe.gov/aer/overview.html).

————2001c, Natural gas annual 1999: U.S. Department of Energy DOE/EIA-0131(99) (available on the Web at: http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/nat_data_publications.html).

————2001d, State energy data report 1999; consumption estimates: U.S. Department of Energy DOE/EIA-0214(99), p. 245 (available on the Web at: http://www.eia.doe.gov/emeu/sedr/contents.html).

Johnson, K. S.; Branson, C. C.; Curtis, N. M., Jr.; Ham, W. E.; Harrison, W. E.; Marcher, M. V.; and Roberts, J. F., 1972, Geology and earth resources of Okla-

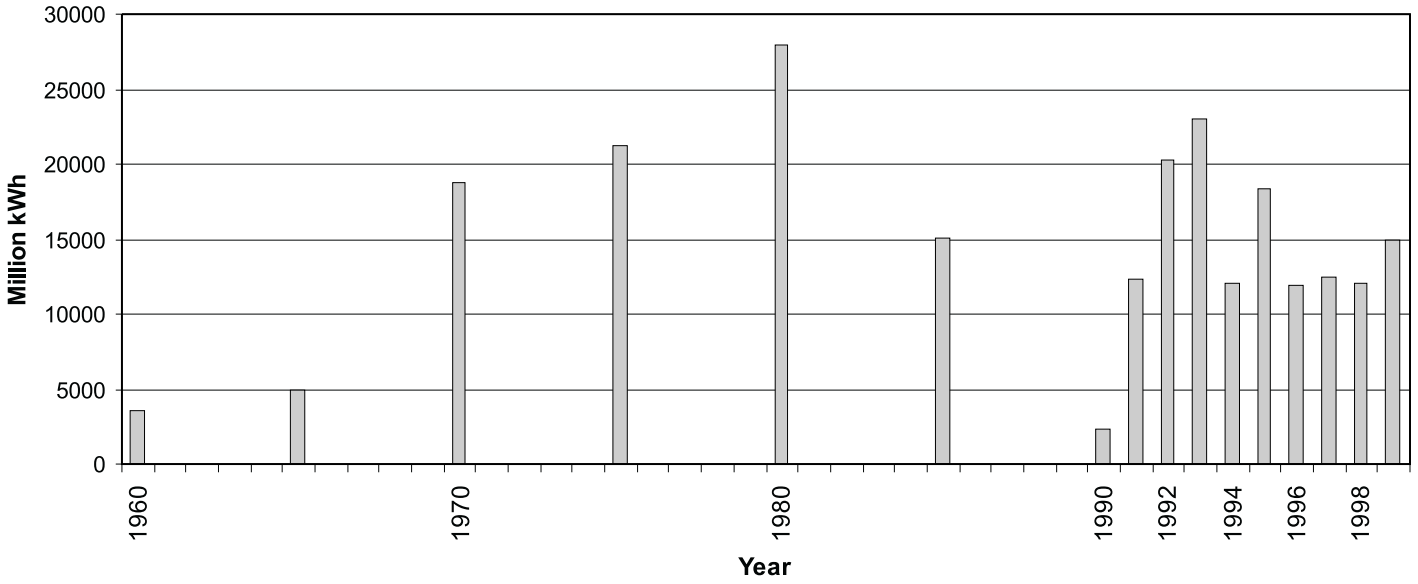


Figure 23. Oklahoma net electricity exports, 1960–1999. Data from Energy Information Administration (2001d, table 233).

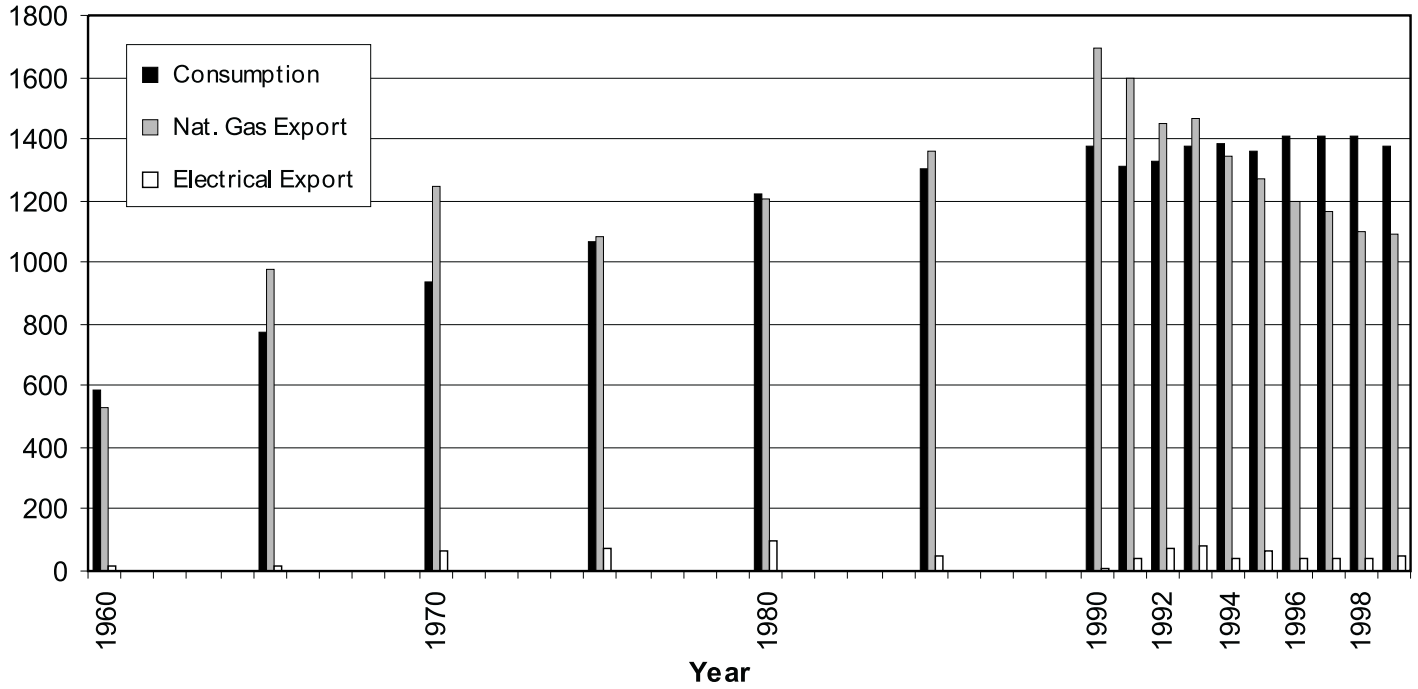


Figure 24. Oklahoma's energy balance, 1960–1999. Data from Energy Information Administration (2001d, 2000b).

homa—an atlas of maps and cross sections: Oklahoma Geological Survey Educational Publication 1, p. 1.
Kentucky Coal Council/Kentucky Coal Association, 1999, Kentucky coal facts, 1999–2000 pocket guide: Kentucky Coal Council/Kentucky Coal Association, Lexington, Kentucky, p. 26–27 (available on the Web at: http://www.coaleducation.org).
Motley, H. W., Jr., 1998, Utilities and industrial location, *in* Späth, H. J.; Thompson, G. L.; and Eisenhart, Henry (eds.), Oklahoma resources for economic development: Oklahoma Geological Survey Special Publication 98-4, p. 177–196.
Natural Resources Information System (NRIS) (accessed July 2001), This database is part of Geo Information Systems, University of Oklahoma, Norman (available on the Web at: http://www.geo.ou.edu/nris/index.htm).
Oklahoma Corporation Commission, accessed July 2001, Oil and gas information: www.occ.state.ok.us/text_files/o&gfiles.htm.
Oklahoma Department of Mines, 2000, Annual report 1999: Oklahoma Mining Commission, Department of Mines, 52 p.
Sanda, A. P. (ed.), 2000, Keystone coal industry manual: Intertec Publishing Corp., Chicago, p. 136, 160, 208–209.
U.S. Bureau of Mines, 1933, Mineral resources of the United States 1931, part 2, nonmetals: U.S. Government Printing Office, Washington, D.C., 675 p.
————1950, Minerals yearbook 1948: U.S. Government Printing Office, Washington, D.C., 1652 p.
U.S. Geological Survey, 1926, Mineral resources of the United States 1923, part 2, nonmetals: U.S. Government Printing Office, Washington, D.C., 750 p.

Glossary of Terms

barrel—42 U.S. gallons.

bbls—Barrels.

BCF—Billion cubic feet of gas (at surface temperature and pressure).

bituminous—A class of high-rank coal, between subbituminous and anthracite, having a calorific value of ≥11,500 Btu/pound.

Btu—British thermal unit. Quantity of heat necessary to raise the temperature of one pound of water 1° Fahrenheit.

crude oil—Unrefined liquid hydrocarbons.

dual-fired plant—Electrical plant in which steam can be generated utilizing two different fuels.

fossil fuels—Petroleum, natural gas, coal.

geologic basin—A persistent depression in the surface of the Earth into which sediments are deposited. It is also the focus for the generation of oil and natural gas.

hydroelectricity—Electricity that is generated through the use of falling water, usually through a manmade dam.

kilowatt—Unit of power equal to 1,000 watts.

kilowatt-hour—Unit of energy equal to that done by one kilowatt acting for one hour.

MCF—Thousand cubic feet of gas (at surface temperature and pressure).

MMCF—Million cubic feet of gas (at surface temperature and pressure).

MMCF/D—Million cubic feet of gas per day.

megawatt—One million watts of electricity.

natural gas—Hydrocarbons that exist as a gas at temperatures and pressures at the Earth's surface.

NRIS—Natural Resources Information System.

petroleum—Hydrocarbons that exist as liquids at temperatures and pressures at the Earth's surface.

reserves—The portion of the resource base that is economically recoverable. Reserves increase as the price of a commodity increases or technological advances make recovery cheaper. Reserves decrease when a commodity is produced or the price drops.

resources—The total known volume, or gross supply, of a commodity. Resources increase as discoveries are made and decrease as the commodity is produced.

subbituminous—A class of low-rank coal, between lignite and bituminous, having a calorific value of 8,300 to 11,500 Btu/pound.

TCF—Trillion cubic feet of gas (at surface temperature and pressure).

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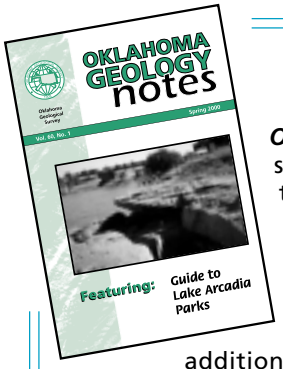

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