**The original documents are located in Box C51, folder "Presidential Handwriting, 11/5/1976 (2)" of the Presidential Handwriting File at the Gerald R. Ford Presidential Library.**

THE WHITE HOUSE
WASHINGTON

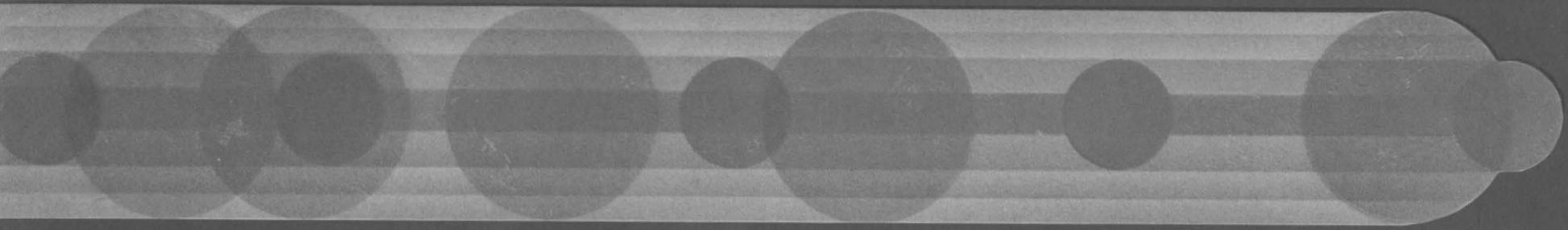
Terry

These would go in a drawer in Oval Office.

Probably should go somewhere where useful.

other copies to Central Files 11/5/74

# ENERGY PERSPECTIVES



U.S. DEPARTMENT OF THE INTERIOR

FEBRUARY 1975

# Energy Perspectives

THE PRESIDENT HAS SEEN.

## A presentation of major energy and energy-related data.


U.S. Department of the Interior

Rogers C.B. Morton,

Secretary of the Interior

Jack W. Carlson,

Assistant Secretary for Energy and Minerals

Principals,

Hermann Enzer
Walter Dupree
Stanley Miller



February 1975

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## U.S. ENERGY RESEARCH AND DEVELOPMENT



## ENERGY AND THE ENVIRONMENT

# Section I

# The World

# World Recoverable Energy Reserves

Forty-nine percent of World recoverable energy reserves are located in North America. Sixteen percent consist of North American solid fuel reserves, and 29 percent of North American oil shale and tar sands.

•

Asia possesses 59 percent of total World crude oil and 24 percent of total World natural gas reserves.

The USSR has 23 percent of World solid fuel reserves, and 32 percent of natural gas reserves.

Total World energy consumption in 1972 represented 1 percent of World energy reserves.

## Measured World Nonrenewable Energy Reserves

**(Quadrillion Btu)[1]**

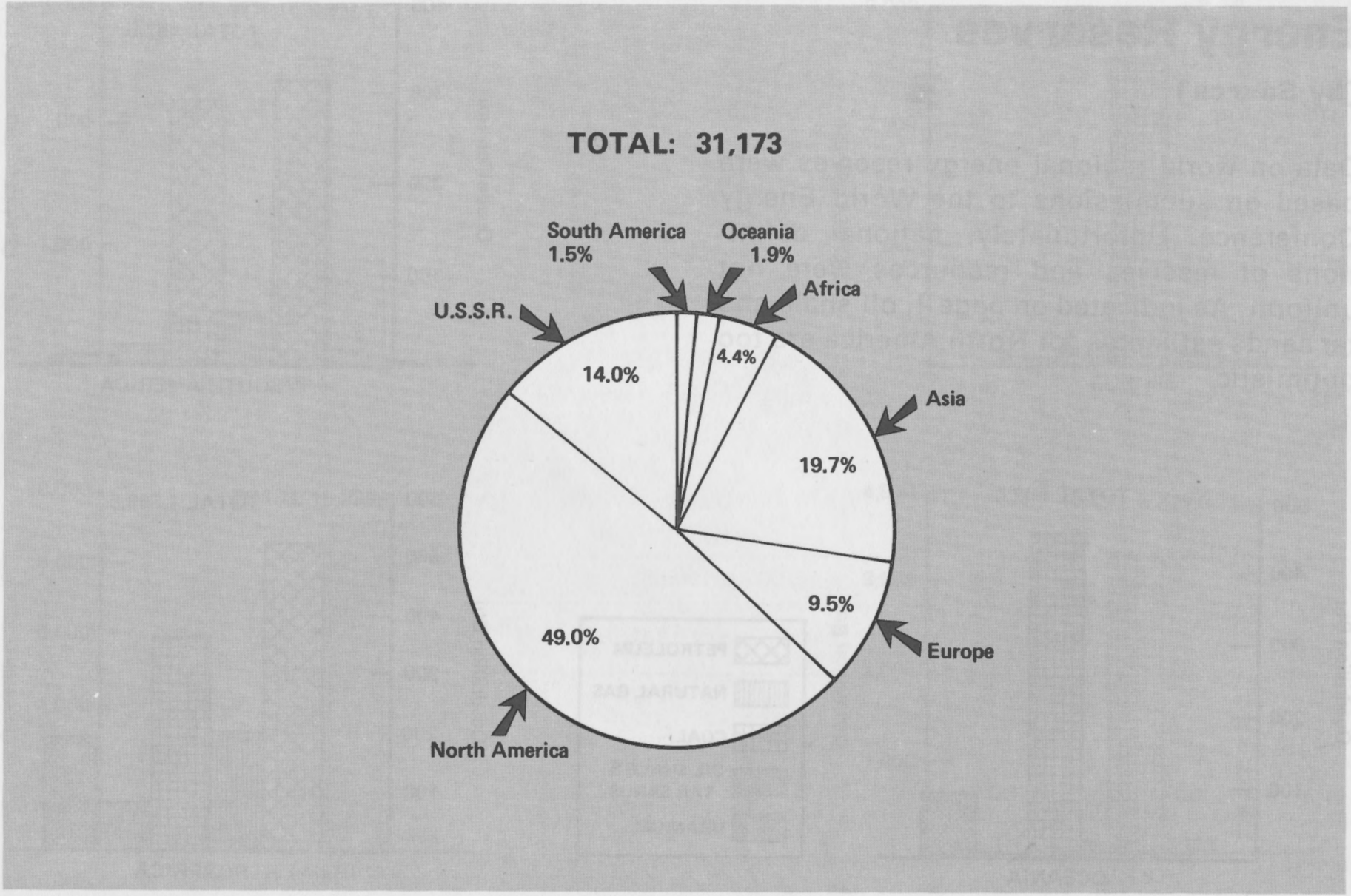
| AREA | FOSSIL FUELS | | | | URANIUM (nonbreeders) | TOTAL |
|---|---|---|---|---|---|---|
| | SOLID FUELS | CRUDE OIL | NATURAL GAS | OIL SHALE AND TAR SANDS | | |
| AFRICA | 361.7 | 526.6 | 201.7 | 81.4 | 198.1 | 1,369.5 |
| ASIA (less U.S.S.R.) | 2,608.7 | 2,211.4 | 432.6 | 870.2 | 3.1 | 6,126.0 |
| EUROPE (less U.S.S.R.) | 2,581.5 | 57.1 | 153.6 | 117.0 | 46.4 | 2,955.6 |
| U.S.S.R. | 3,325.5 | 333.6 | 577.9 | 139.0 | Unknown | >4,376.0 |
| NORTH AMERICA[2] | 5,070.9 | 301.0 | 380.6 | 9,111.0[2] | 422.7 | 15,286.2 |
| SOUTH AMERICA | 49.8 | 311.5 | 60.6 | 23.7 | 11.9 | 457.5 |
| OCEANIA | 459.8 | 9.4 | 24.9 | 9.2 | 99.1 | 602.4 |
| TOTAL | 14,457.9 | 3,741.2 | 1,831.9 | 10,351.5 | >781.3 | >31,173.2 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

[2] According to the Bureau of Mines, North American tar sands and oil shale reserves may be severely overstated. Development of most of these reserves is not economic at the present time.

# World Recoverable Energy Reserves

(Quadrillion Btu)

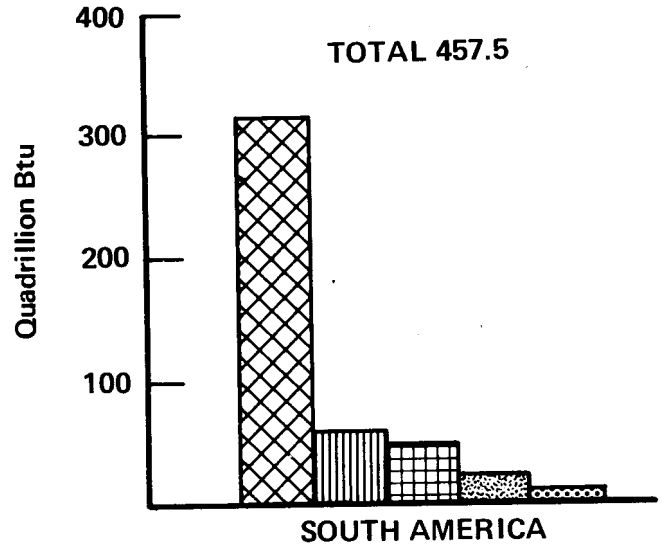


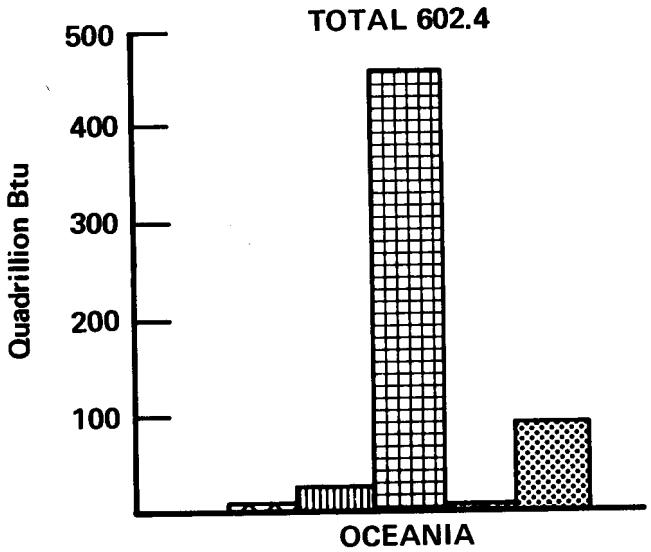

Source: Survey of Energy Resources, World Energy Conference, 1974.

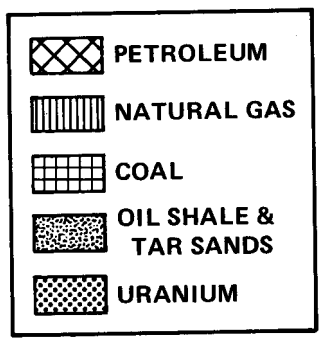
# World Regional Recoverable Energy Reserves

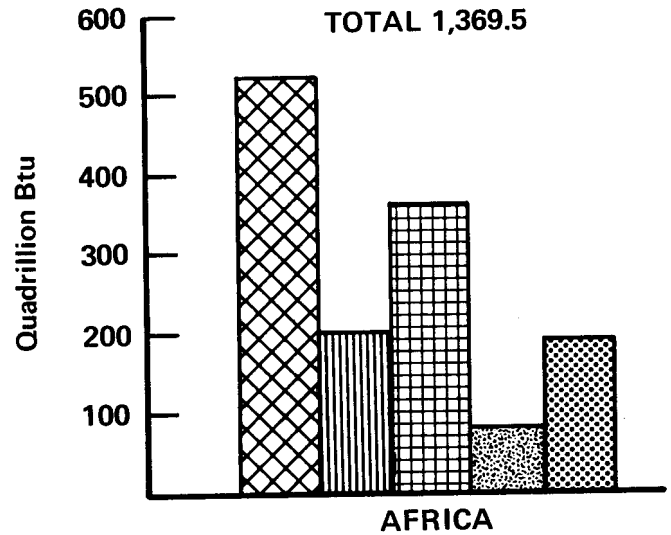
**[by Source]**

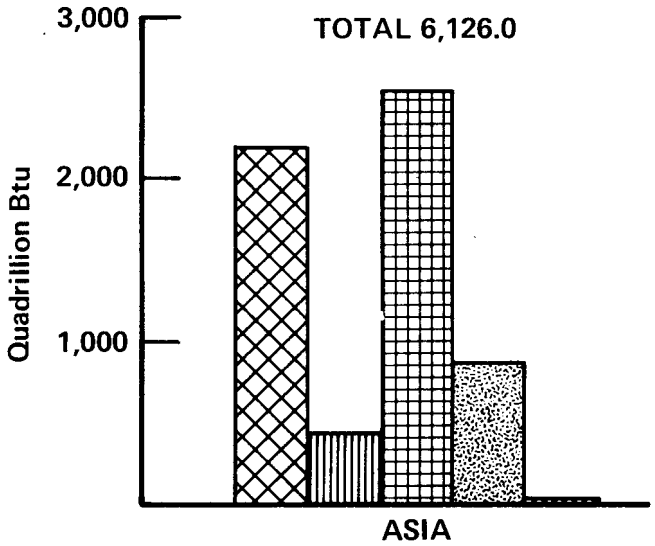
Data on world regional energy reserves were based on submissions to the World Energy Conference. Unfortunately, national definitions of reserves and resources were not uniform. As indicated on page 2, oil shale and tar sands estimates for North America are too optimistic.

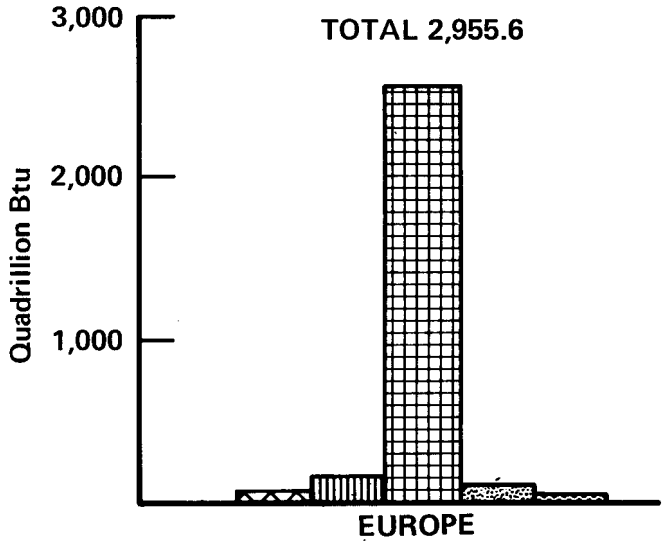


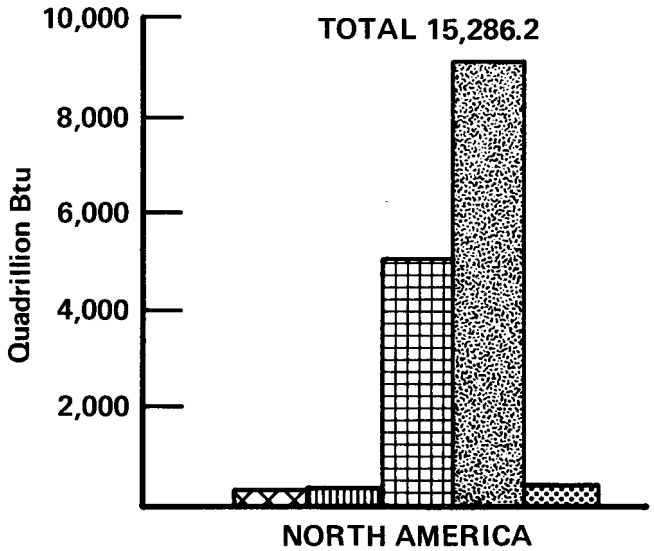



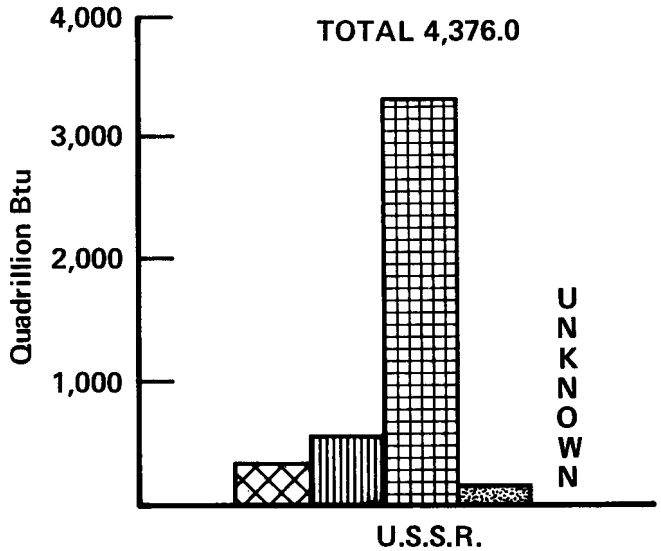






Source: Survey of Energy Resources, World Energy Conference, 1974.

# World Energy Consumption

## [by Region]

From 1960 to 1972, total world energy consumption increased at an annual rate of 4.9 percent. The projected annual rate of increase from 1972 to 1990 is 3.3 percent.

From 1972 to 1990, U.S. energy consumption is projected to increase 3 percent annually as compared to a 4.1-percent growth rate for the 1960-72 period.

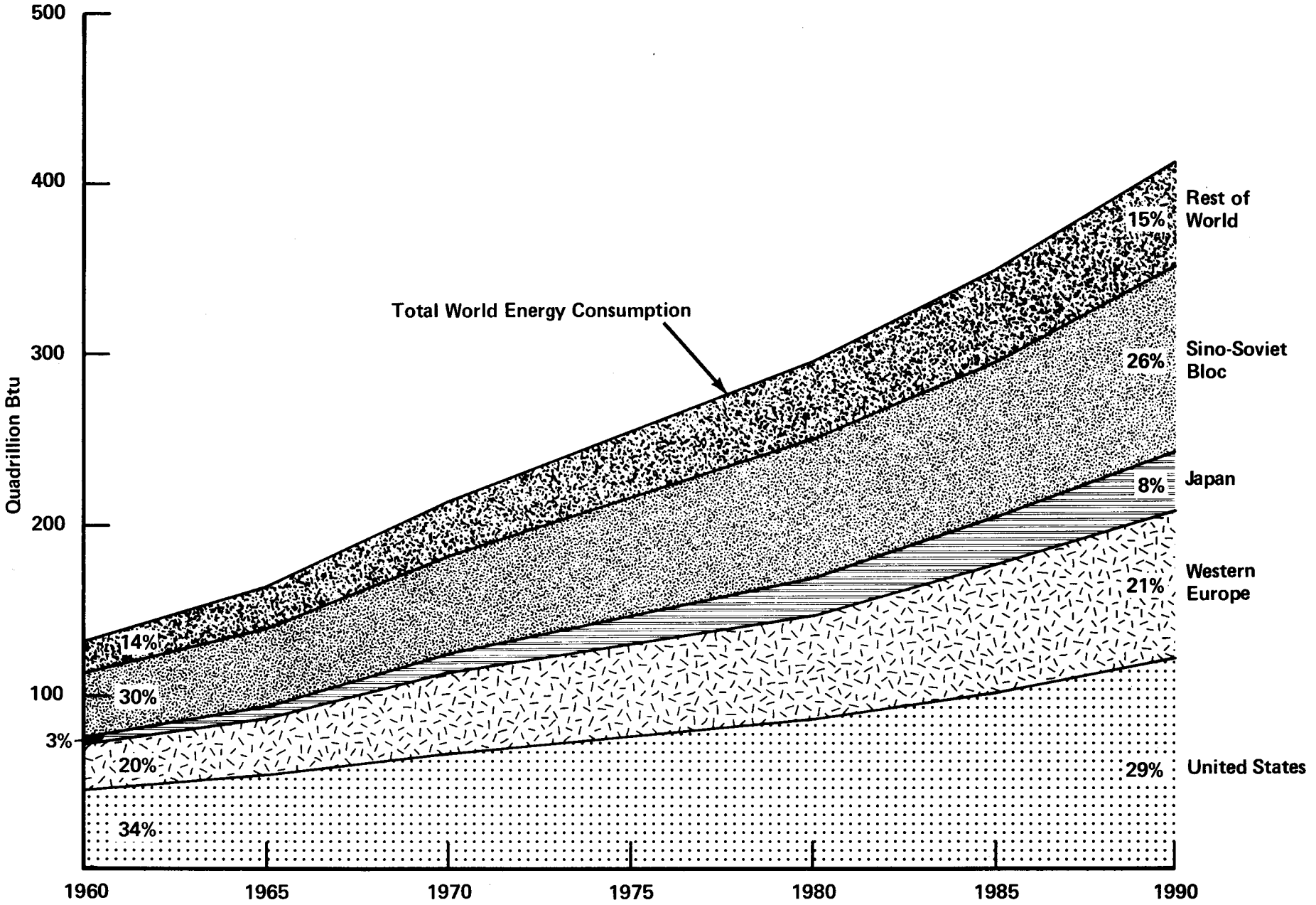
### World Energy Consumption, by Region, 1960-90

(Quadrillion Btu)[1]

| REGION | 1960 | 1965 | 1970 | 1972 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|---|---|
| UNITED STATES | 44.6 | 53 3 | 67.0 | 72.0 | 86.3 | 102.9 | 121.9 |
| WESTERN EUROPE | 26.4 | 34.4 | 46.0 | 49.1 | 62.6 | 75.2 | 87.2 |
| JAPAN | 3.7 | 6.2 | 12.0 | 13.4 | 20.4 | 26.7 | 34.0 |
| SINO-SOVIET BLOC | 39.0 | 45.2 | 58.3 | 63.7 | 82.0 | 94.0 | 109.0 |
| REST OF WORLD | 18.0 | 24.3 | 33.6 | 35.7 | 45.0 | 52.1 | 60.4 |
| TOTAL | 131.7 | 163.4 | 216.9 | 233.9 | 296.3 | 350.9 | 416.5 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# World Energy Consumption by Region, 1960-90




Source: Historical data: United Nations, 1974;
Projections: U.S. Department of the Interior.

# World Energy Consumption

## [by Source]

World energy consumption increased at an annual rate of 4.9 percent from 1960 to 1972, and is projected to increase at a 3.3-percent annual rate from 1972 to 1990.

Coal is projected to increase at a 1.8-percent annual rate, petroleum at 2.4 percent, natural gas at 2.9 percent, hydropower and geothermal at 2.1 percent, and nuclear power at a 23.6-percent annual rate during the 1972-90 period.

In 1990, coal is projected to constitute approximately 22 percent of total world energy consumption, petroleum 40 percent, natural gas 19 percent, hydropower and geothermal 5 percent, and nuclear power 15 percent.

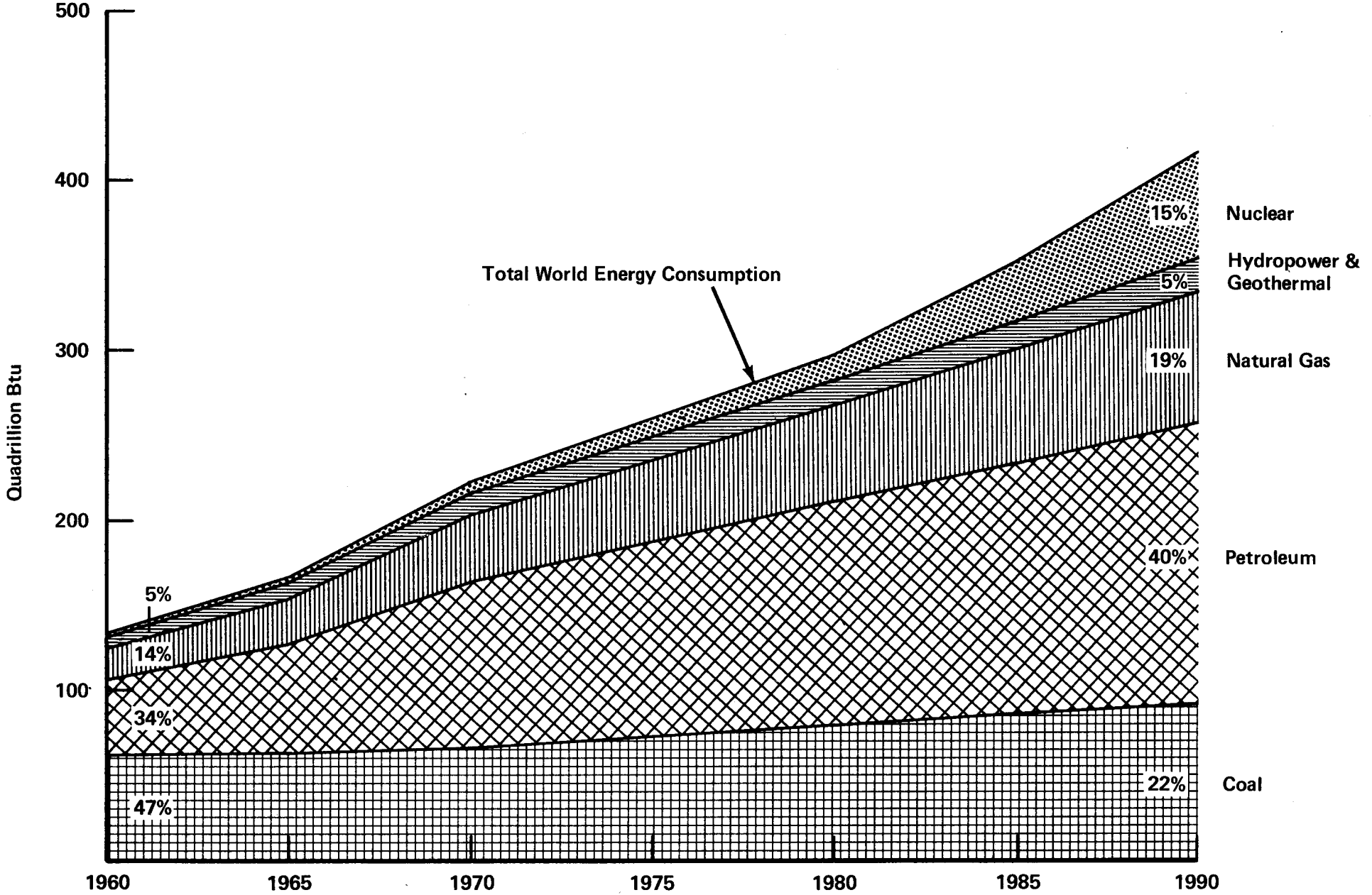
**World Energy Consumption by Source, 1960-90**

**(Quadrillion Btu)[1]**

| ENERGY SOURCE | 1960 | 1965 | 1970 | 1972 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|---|---|
| COAL | 61.5 | 62.6 | 66.8 | 66.3 | 79.2 | 85.7 | 92.0 |
| PETROLEUM | 45.3 | 64.4 | 96.9 | 107.5 | 132.3 | 147.2 | 165.0 |
| NATURAL GAS | 18.0 | 26.6 | 40.6 | 45.8 | 56.8 | 67.3 | 77.1 |
| HYDROPOWER & GEOTHERMAL | 6.9 | 9.6 | 11.8 | 12.9 | 15.4 | 17.1 | 18.8 |
| NUCLEAR | | .2 | .8 | 1.4 | 12.6 | 33.6 | 63.6 |
| TOTAL | 131.7 | 163.4 | 216.9 | 233.9 | 296.3 | 350.9 | 416.6 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# World Energy Consumption by Source, 1960-90




Source: Historical data: United Nations, 1974;
Projections: U.S. Department of the Interior.

# World Energy Inputs

**[Electrical Sector]**

Energy inputs for world electrical generation increased at an annual rate of 7.6 percent between 1960 and 1972, and are projected to increase at an annual rate of 6.4 percent between 1972 and 1990.

Nuclear energy is expected to be the fastest-growing energy input during the 1972-90 period, increasing at an annual rate of 23.6 percent. In 1990, nuclear energy is projected to provide 37 percent of total energy inputs for world electrical generation.

Given business as usual, $11 oil, nuclear energy is projected to provide 41 percent of total U.S. electrical generation in 1990.

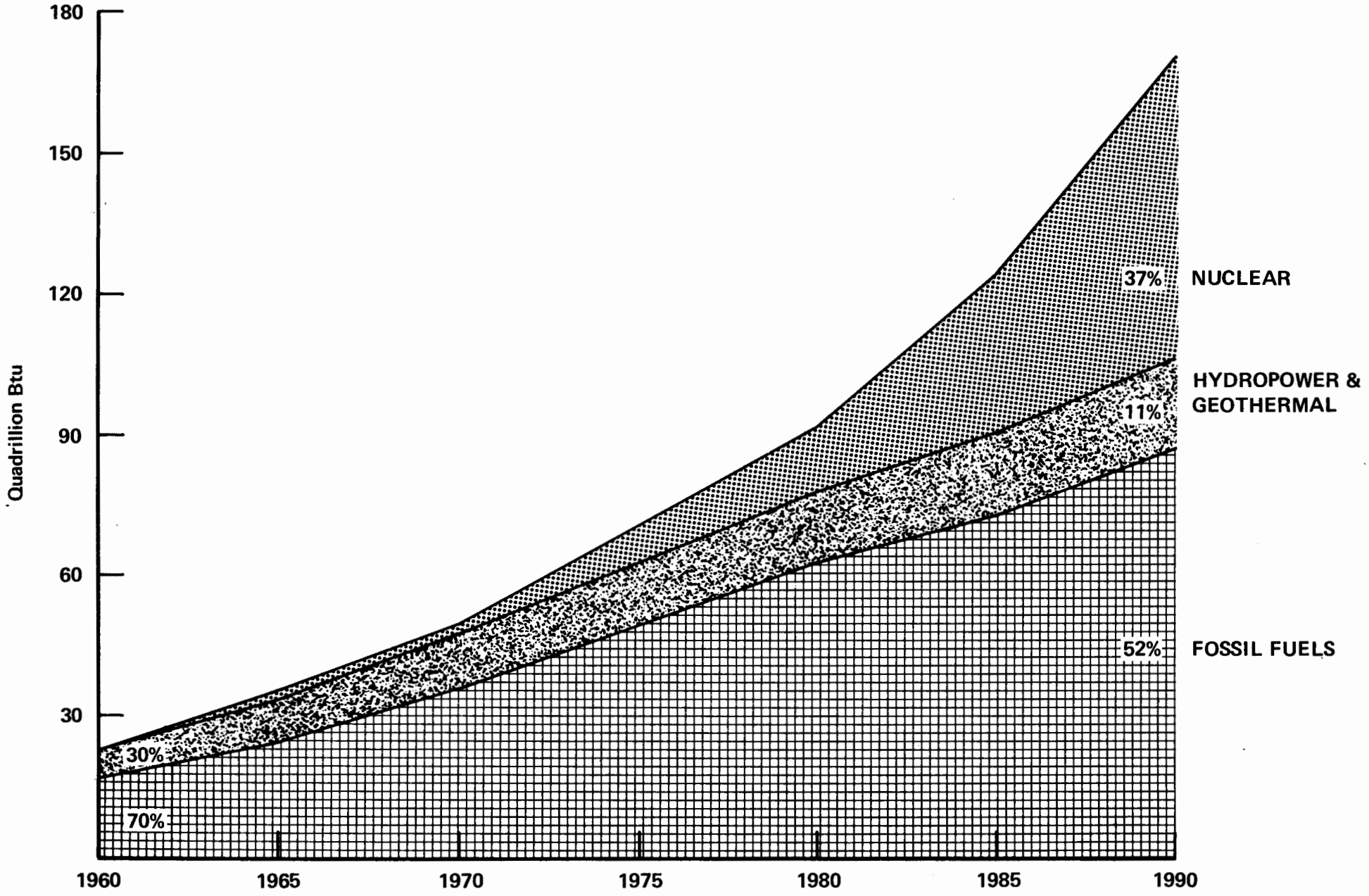
**World Energy Inputs, Electrical Sector, 1960-90**

**(Quadrillion Btu)[1]**

| YEAR | FOSSIL FUELS | HYDROPOWER & GEOTHERMAL | NUCLEAR | TOTAL |
|---|---|---|---|---|
| 1960 | 16.1 | 6.9 | --- | 23.0 |
| 1965 | 24.4 | 9.6 | 0.2 | 34.2 |
| 1970 | 36.6 | 11.8 | .8 | 49.2 |
| 1972 | 41.6 | 12.8 | 1.4 | 55.8 |
| 1980 | 63.0 | 15.4 | 12.6 | 91.0 |
| 1985 | 73.3 | 17.1 | 33.6 | 124.0 |
| 1990 | 87.6 | 18.8 | 63.6 | 170.0 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# World Energy Inputs, Electrical Sector, 1960-90




Source: Historical data: United Nations, 1974;
Projections: U.S. Department of the Interior.

# World Petroleum Production and Consumption

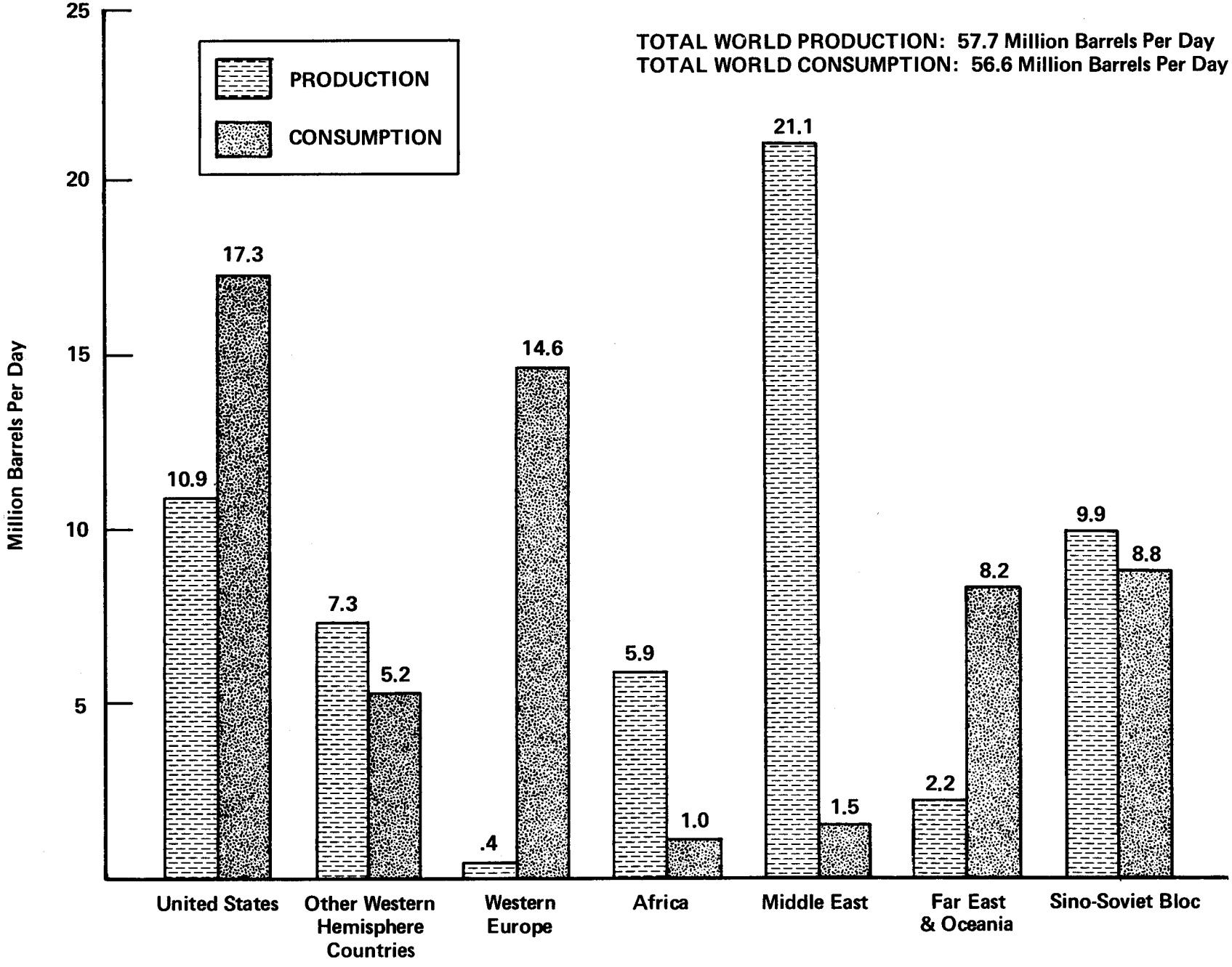
The following regions were exporters of petroleum in 1973: the Middle East, Africa, the Sino-Soviet region, and Western Hemisphere countries (excluding the United States).

Petroleum production in the Middle East exceeded consumption by 19.6 million barrels a day.

The United States, Western Europe, and the Far East and Oceania were net importers of petroleum in 1973.

In 1973, U.S. consumption of petroleum exceeded production by 6.4 million barrels a day.

# World Petroleum Production and Consumption, 1973




Source: Twentieth Century Petroleum Statistics, DeGolyer and McNaughton, 1974.

# World Crude Oil Reserves

**[by Region]**

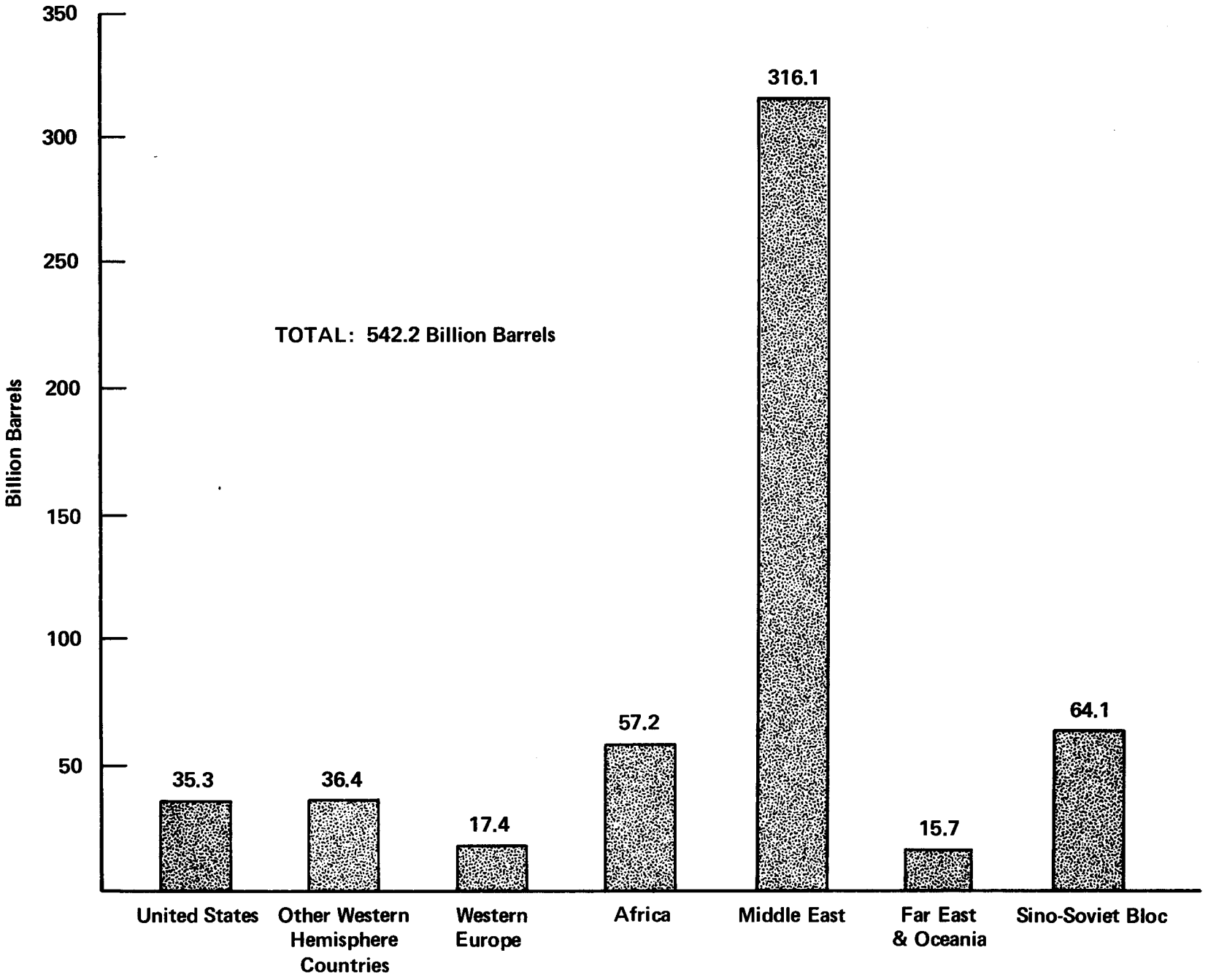
In 1973, total world crude oil reserves were estimated to be 542.2 billion barrels.

During that year total world crude oil production was 57.7 million barrels per day, or 21.1 billion barrels for the year.

Fifty-eight percent of total world reserves were located in the Middle East, and 11 percent in Africa.

In 1973, U.S. crude oil reserves constituted but 7 percent of total world crude oil reserves.

# World Crude Oil Reserves, by Region, 1973




Source: Twentieth Century Petroleum Statistics, DeGolyer and McNaughton, 1974.

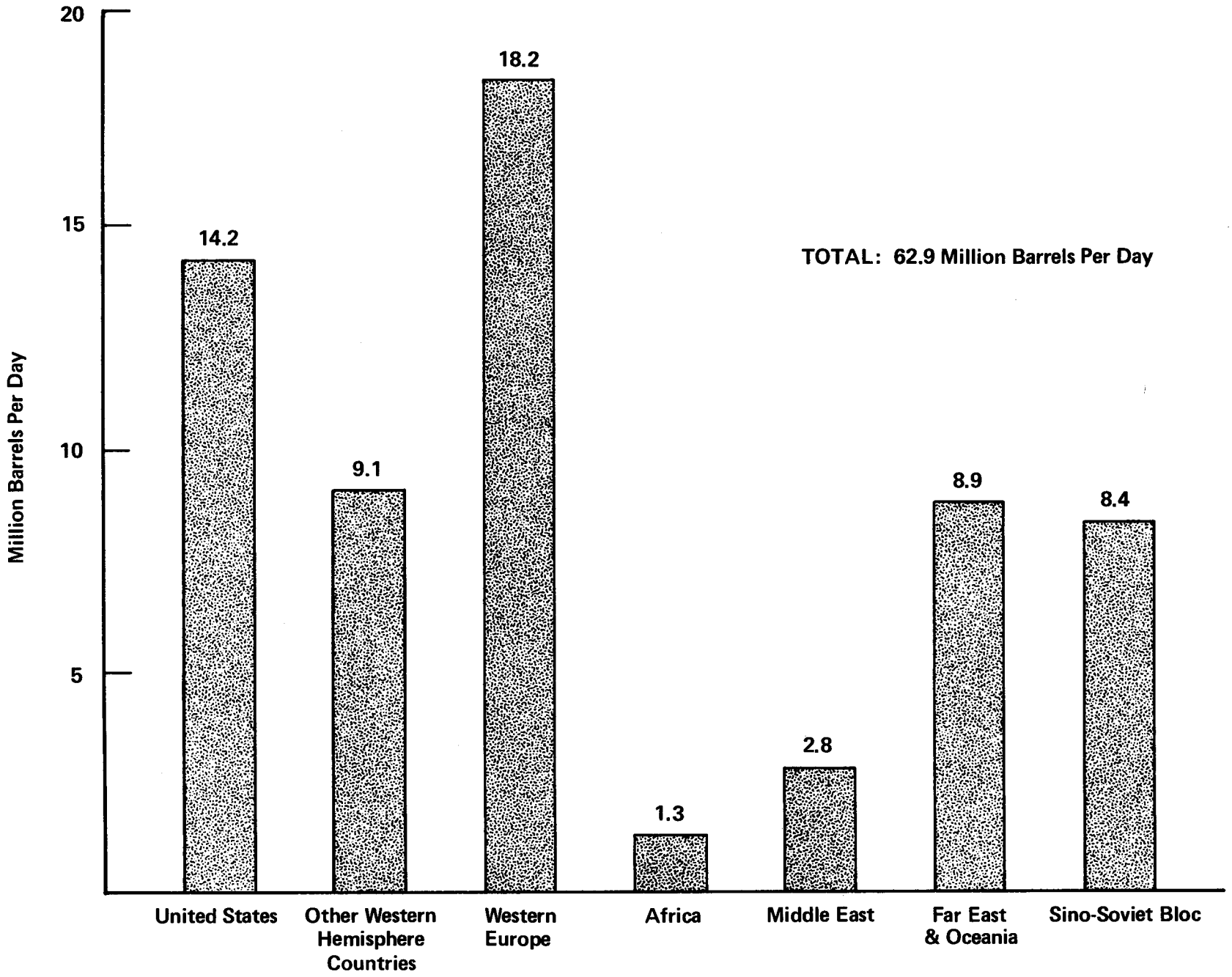
# World Petroleum Refining Capacity

In 1973, 29 percent of the total world petroleum refining capacity of 62.9 million barrels a day was located in Western Europe.

The United States possessed 23 percent and other Western Hemisphere countries had 14 percent of the refining capacity of the world.

World refining capacity in 1974 did not significantly increase in comparison to 1973.

# World Petroleum Refining Capacity, 1973



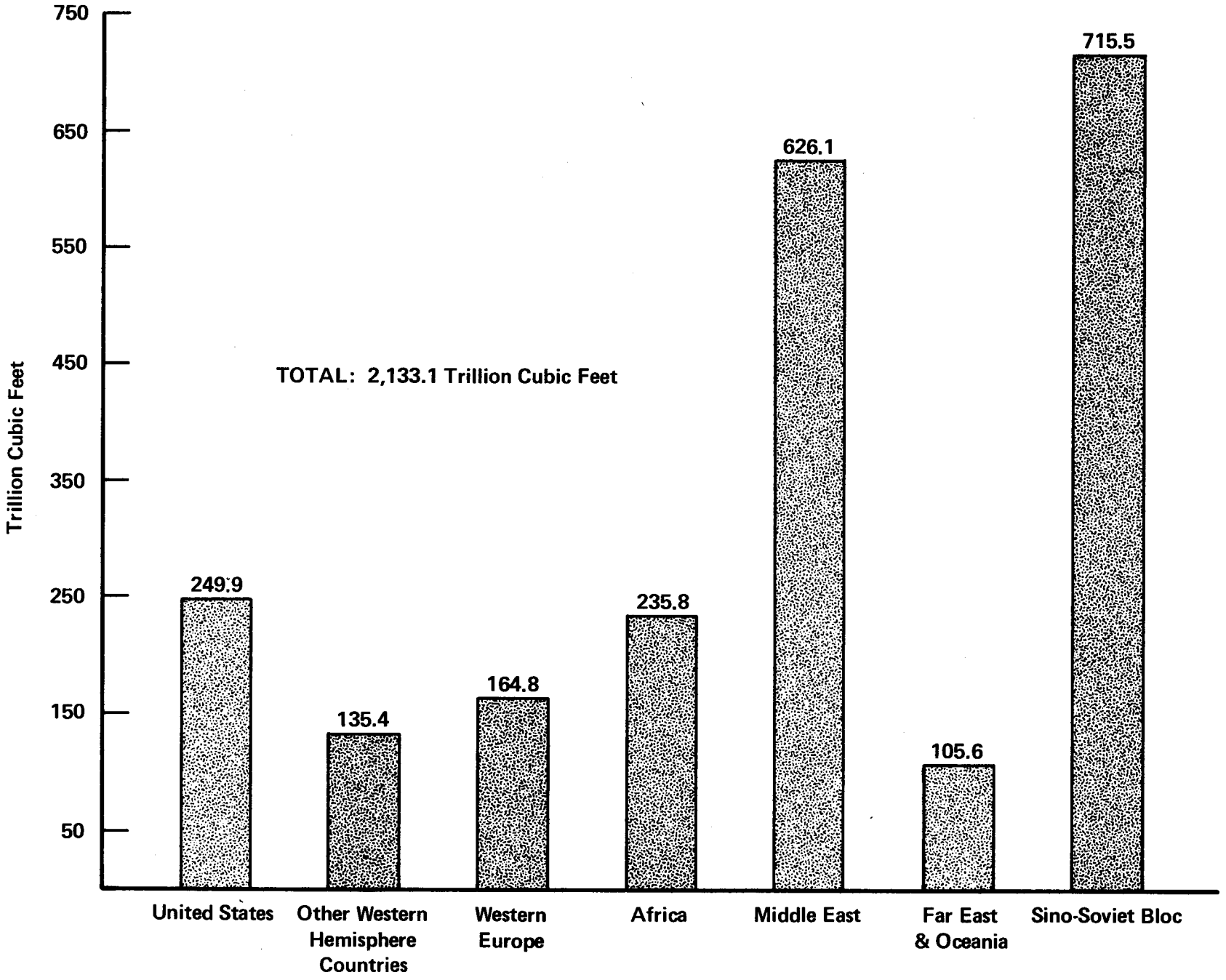

Source: Oil and Gas Journal, 1974; U.S. Bureau of Mines, 1974.

# World Natural Gas Reserves

In 1973, 34 percent of the 2,133.1 trillion cubic feet of world natural gas reserves were located in the Sino-Soviet bloc, and 29 percent in the Middle East.

The United States, which produced 51 percent of world marketed natural gas in 1973, possessed 12 percent of the natural gas reserves of the world.

# World Natural Gas Reserves, 1973




Source: U.S. Geological Survey, 1974; World Oil, August 15, 1974, pages 64-191.

# World Natural Gas Production[1]

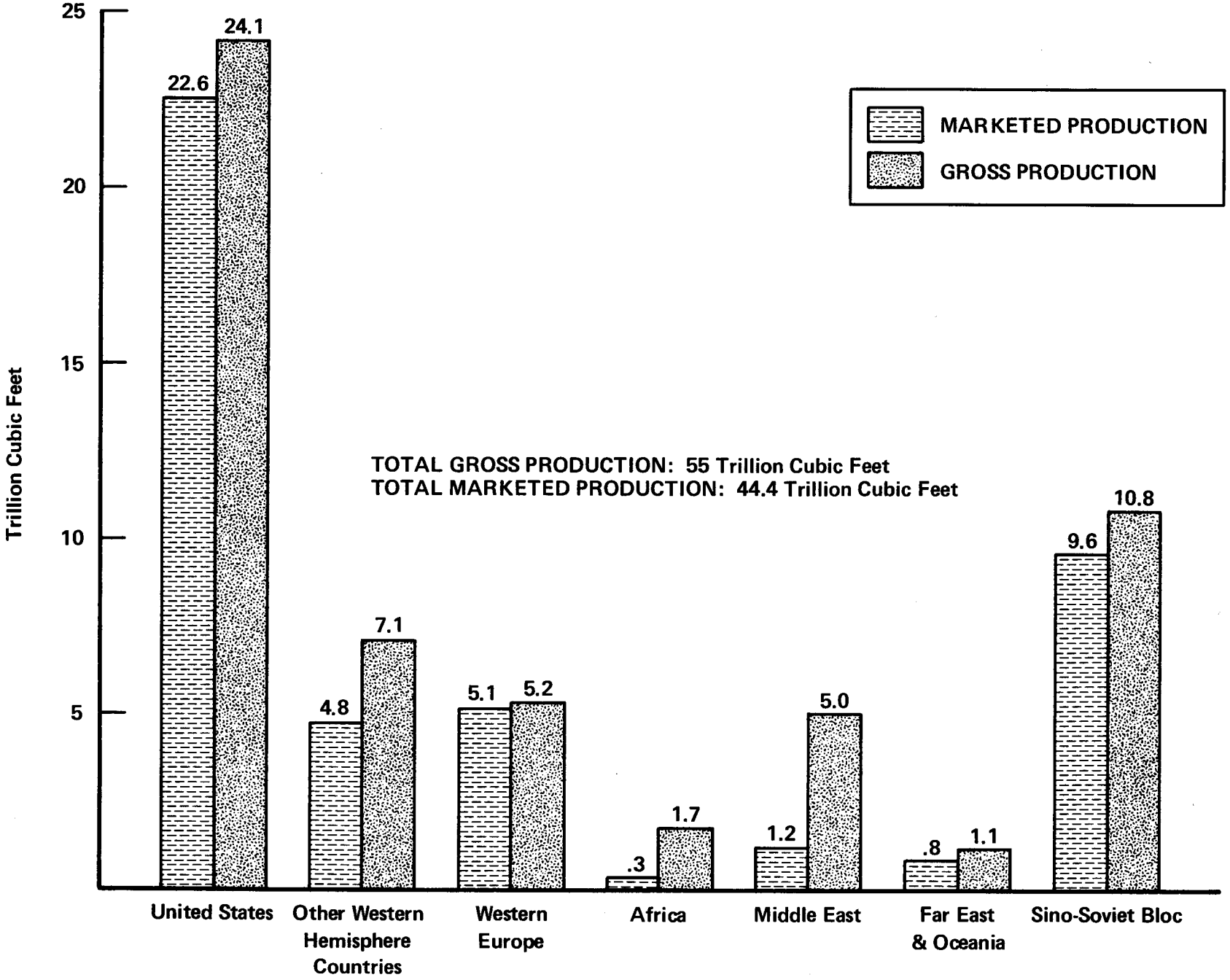
World gross natural gas production in 1973 was 55 trillion cubic feet, or 3 percent of total world natural gas reserves.

The United States produced 44 percent and the Sino-Soviet bloc 20 percent of total world gross natural gas production in 1973.

While the United States, Western Europe, and the Sino-Soviet bloc marketed the bulk of their gross natural gas production, the Middle East and Africa flared much of their natural gas.

[1] Gross production refers to gross withdrawals of natural gas. Marketed natural gas refers to gross production less gas used for repressuring and quantities vented and flared.

# World Natural Gas Production, 1973




Source: U.S. Bureau of Mines, 1974.

# World Coal Production

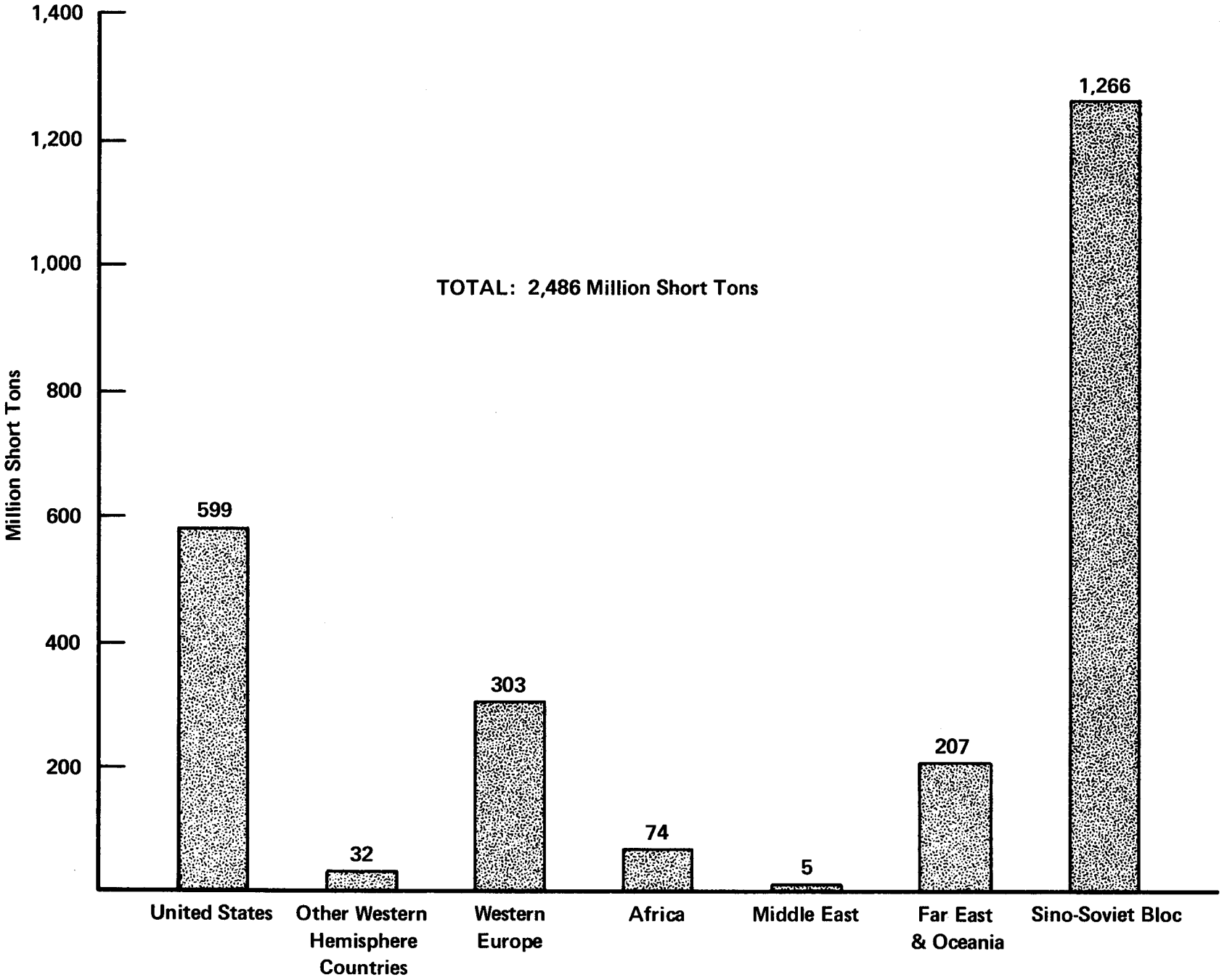
In 1973, world coal production of 2,471 million short tons constituted less than 1 percent of world recoverable coal reserves.

The Sino-Soviet bloc was the largest regional coal producer, with 51 percent of total world coal production.

The United States, with 32 percent of world recoverable coal reserves, was the second largest regional coal producer, contributing 24 percent to total world coal production.

Note.—Coal production includes anthracite and bituminous coal and not lignite production.

# World Coal Production, 1973




Source: U.S. Bureau of Mines, 1974.

# World Recoverable Coal Reserves[1]

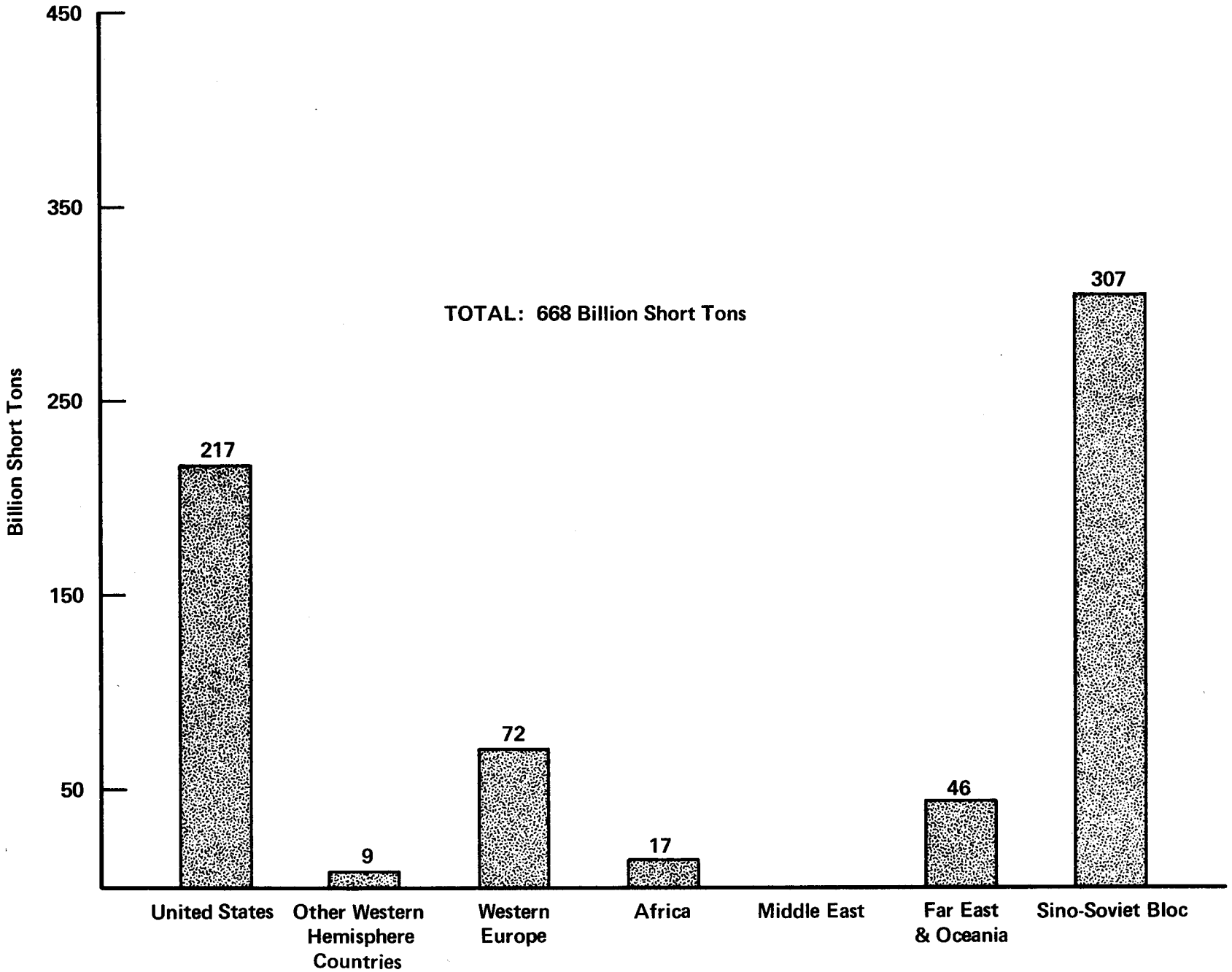
World coal reserves were estimated to be 668 billion short tons in 1973. Coal production was 2.47 billion short tons that year.

In 1973, 46 percent of total world recoverable coal reserves[1] were located in the Sino-Soviet bloc countries. The United States possessed 32 percent of recoverable coal reserves and produced 24 percent of total world coal output.

The Middle East did not have any recoverable coal reserves. Other Western Hemisphere countries, Africa, and the Far East and Oceania possessed but 11 percent of total world recoverable coal reserves.

[1] Recoverable reserves are identified reserves known to be recoverable with current technology under present economic conditions. Total recoverable reserves will vary as a percentage of the reserve base on a regional basis. A 50-percent ratio was assumed for the United States; i.e., it was assumed that 50 percent of the U.S. demonstrated proved coal reserve base was recoverable. U.S. figures have been adjusted to reflect estimates that are more recent than those submitted to the World Energy Conference.

# World Recoverable Coal Reserves, 1973




Source: Survey of Energy Resources, World Energy Conference, 1974; U.S. Bureau of Mines, 1974.

# World Hydroelectric Power

**[Developed and Undeveloped]**

In 1973, Asia, excluding the U.S.S.R., possessed 30 percent of total world potential hydroelectric power. In contrast, North America had 15 percent of the world total.

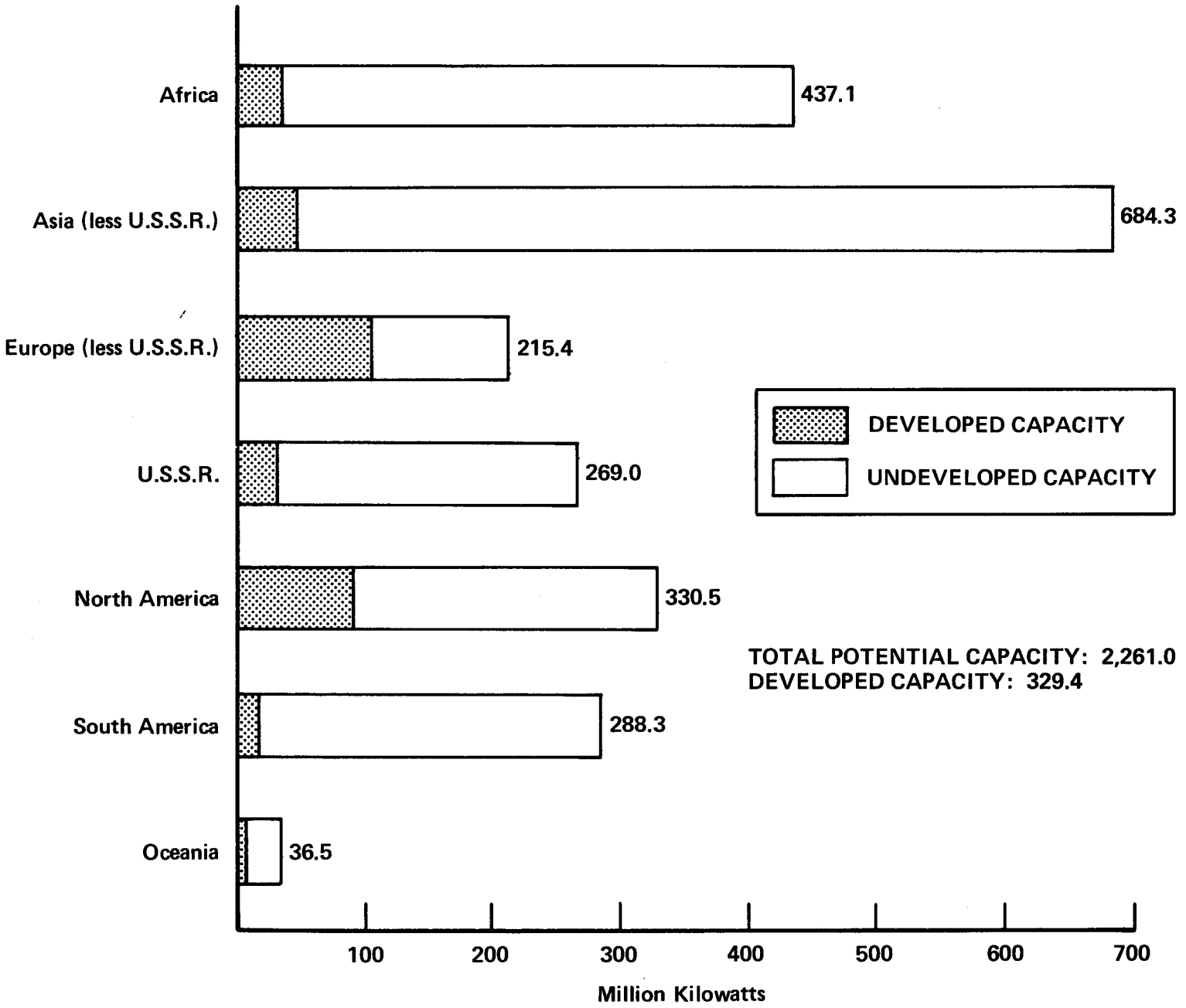
Europe, less the U.S.S.R., has developed 48 percent of its potential, North America 27 percent, and Asia, excluding the U.S.S.R., 7 percent of its potential hydroelectric capacity. In 1973, the world had developed only 15 percent of total potential hydroelectric capacity.

**World Hydroelectric Power, Developed and Undeveloped, 1973**

**(Million Kilowatts)**

| AREA | TOTAL POTENTIAL CAPACITY | TOTAL DEVELOPED CAPACITY |
|---|---|---|
| AFRICA | 437.1 | 30.2 |
| ASIA (less U.S.S.R.) | 684.3 | 47.1 |
| EUROPE (less U.S.S.R.) | 215.4 | 104.0 |
| U.S.S.R. | 269.0 | 31.5 |
| NORTH AMERICA | 330.5 | 90.2 |
| SOUTH AMERICA | 288.3 | 18.8 |
| OCEANIA | 36.5 | 7.6 |
| TOTAL | 2,261.0 | 329.4 |

# World Hydroelectric Power, Developed and Undeveloped, 1973




Source: Survey of Energy Resources, World Energy Conference, 1974.

# Section II

# The United States

# U.S. Recoverable Energy Resources

The most abundant energy resource in the United States is coal,[1] with a demonstrated reserve base[2] 12 to 19 times greater than petroleum reserves.

Shale oil resources[3] compare favorably with natural gas and petroleum reserves and are based upon recoverable resources of 80-200 billion barrels of oil (25 gallons per ton of shale).

U.S. energy reserves and resources presented in the following figure should be related to total 1973 U.S. energy consumption of 34.7 quadrillion Btus of petroleum, 22.8 quadrillion Btus of natural gas, and 13.4 quadrillion Btus of coal.

Geothermal resources do not include paramarginal resources of 4,000 quadrillion Btu that would be recoverable given further technological improvements.

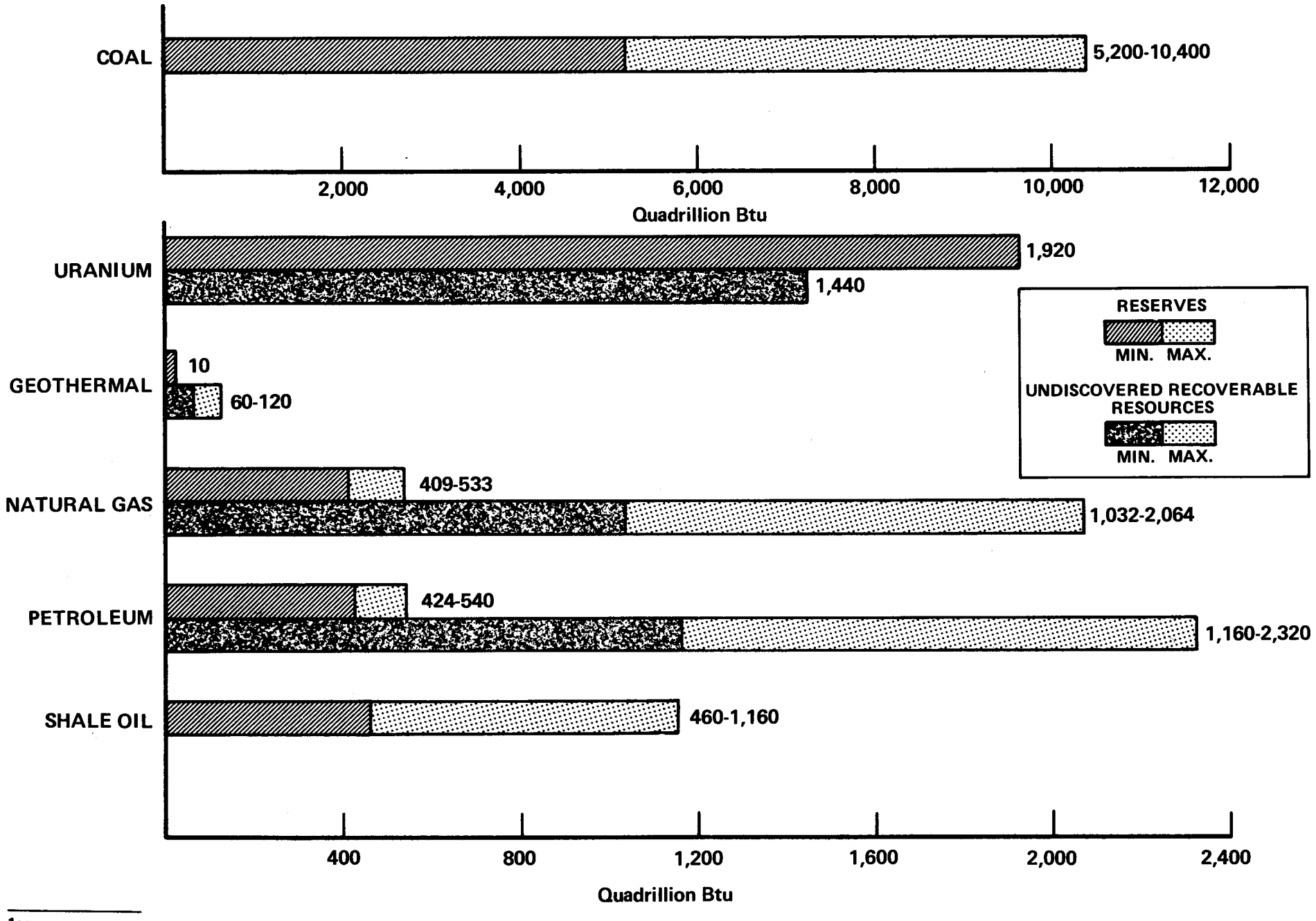
---

[1] The range in coal reserves is based upon the recoverability of the coal reserve base which, under existing methods, varies from 40 to 90 percent for individual deposits. A 50-100-percent recoverability range was used for the coal reserve recoverability range.

[2] Reserves are identified deposits which are known to be recoverable with current technology under present economic conditions. Undiscovered recoverable resources are quantities of resources that may be reasonably expected to exist in favorable geologic settings, but which have not yet been identified by drilling. Conversion of undiscovered recoverable resources to proven reserves will significantly extend U.S. energy supplies.

[3] A shale oil discovered recoverable resource range of 460 to 1,160 quadrillion Btu (or 80 to 200 billion barrels) is the most accepted estimate of total recoverable oil. Additional resources of 600 billion barrels have been identified, but recoverability of such resources is dubious given existing technology.

# U.S. Recoverable Energy Resources




[1]Uranium recoverable resources are based upon $U_3O_8$ prices of $50 a pound of less. The energy content was evaluated in relationship to the lightwater reactor, and assumed to be 400 x $10^9$ Btu per ton.

Source: U.S. Geological Survey, 1974; Atomic Energy Commission, 1974.

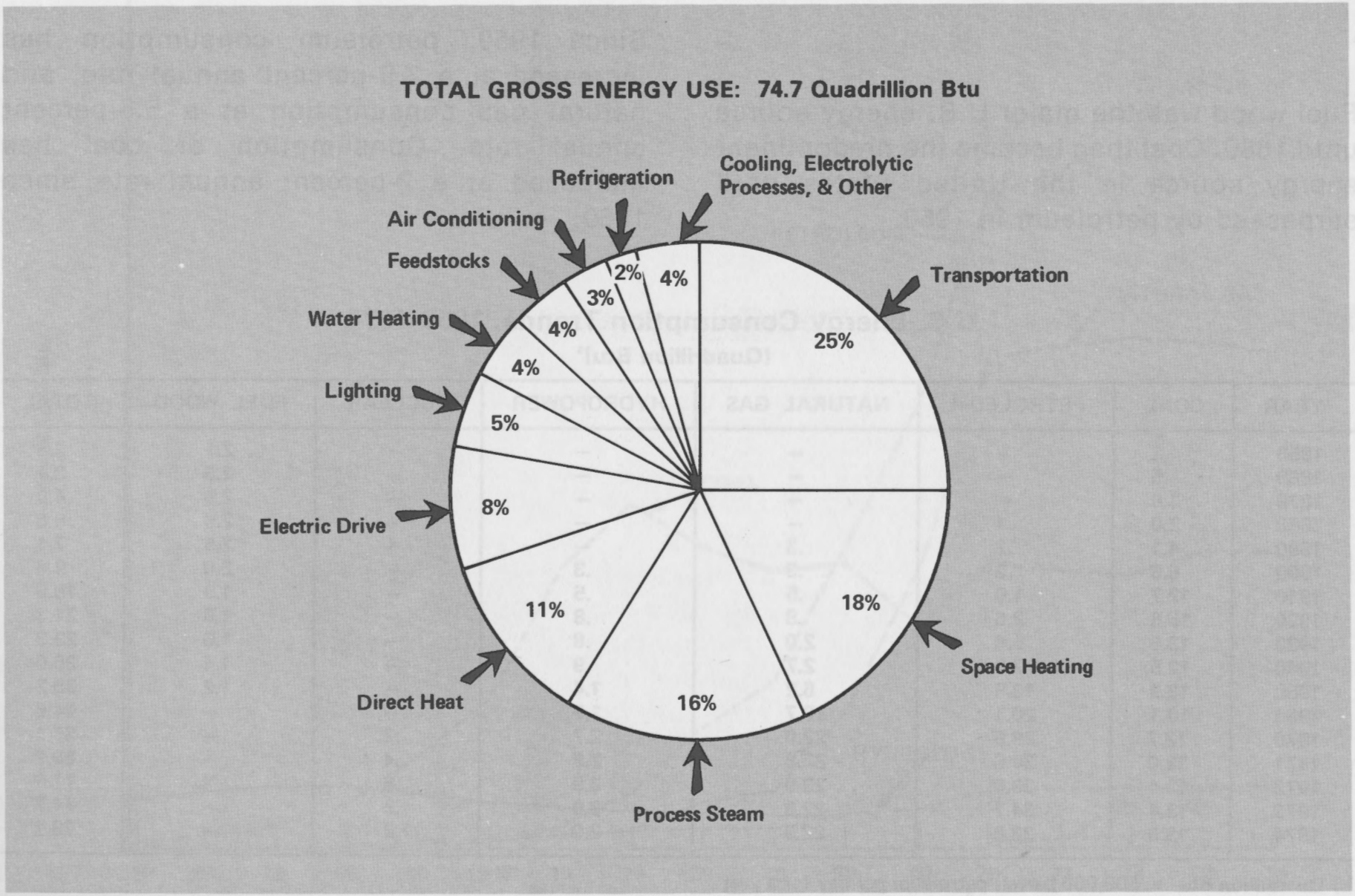
# U.S. Gross Energy End Uses

In 1973, one-fourth of total gross energy consumption[1] in the United States was expended in the transportation sector, primarily for automobile and aircraft tripmaking.

Space heating and process steam accounted for 18 and 16 percent, respectively, of total gross energy consumption in 1973.

[1] Gross consumption includes conversion losses by the electric power sector.

# U.S. Gross Energy End Uses, 1973




Source: U.S. Energy Prospects: An Engineering Viewpoint, National Academy of Engineering, 1974, page 26.

# U.S. Energy Consumption Trends

Fuel wood was the major U.S. energy source until 1880. Coal then became the predominant energy source in the United States until surpassed by petroleum in 1950.

Since 1950, petroleum consumption has increased at a 3.9-percent annual rate, and natural gas consumption at a 5.5-percent annual rate. Consumption of coal has increased at a 2-percent annual rate since 1960.

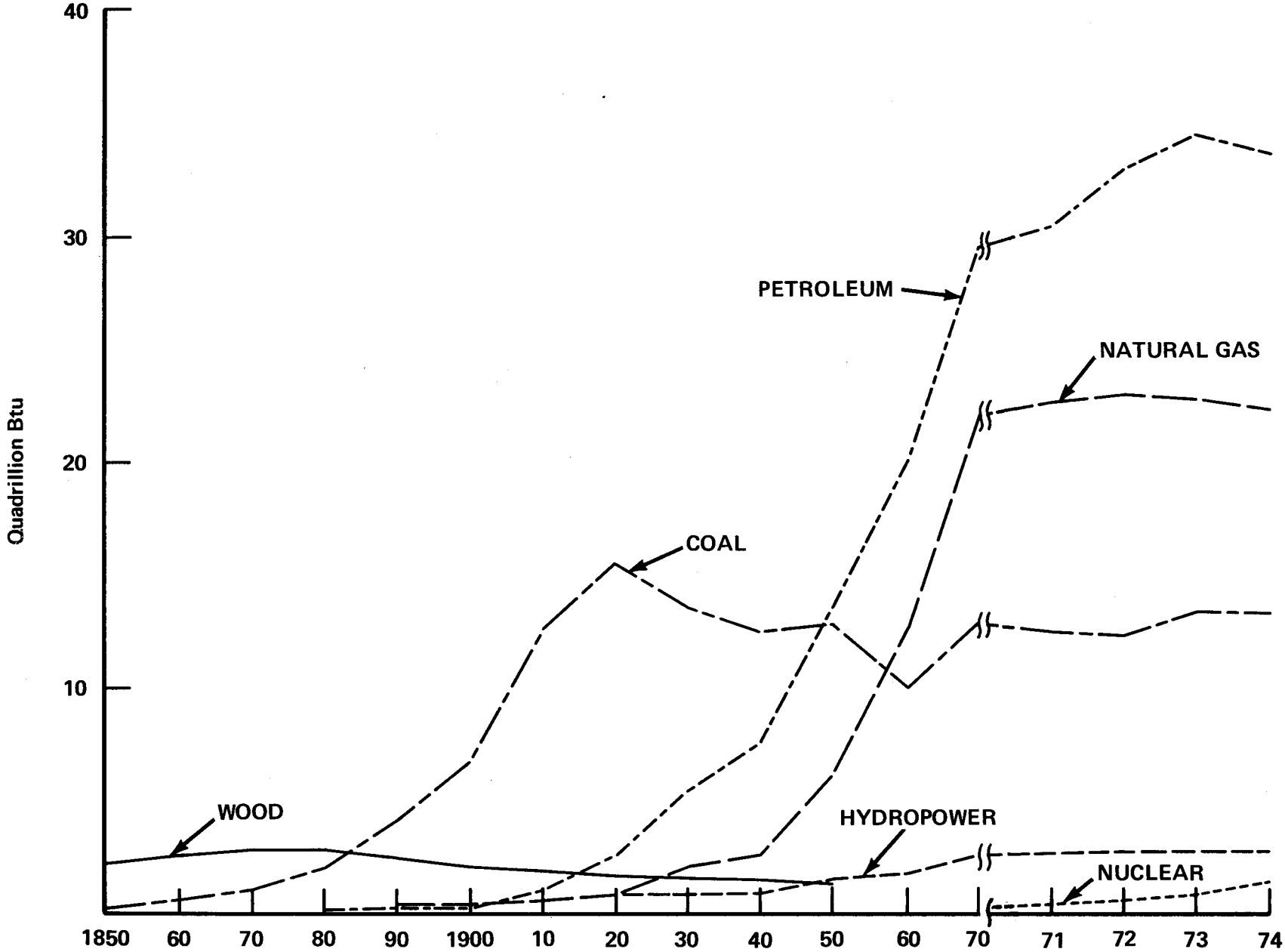
## U.S. Energy Consumption Trends, 1850-1974

(Quadrillion Btu)[1]

| YEAR | COAL | PETROLEUM | NATURAL GAS | HYDROPOWER | NUCLEAR | FUEL WOOD | TOTAL |
|---|---|---|---|---|---|---|---|
| 1850 | .2 | – | – | – | – | 2.1 | 2.3 |
| 1860 | .5 | – | – | – | – | 2.6 | 3.1 |
| 1870 | 1.0 | – | – | – | – | 2.9 | 4.0 |
| 1880 | 2.0 | .1 | – | – | – | 2.9 | 5.0 |
| 1890 | 4.1 | .2 | .3 | – | – | 2.5 | 7.1 |
| 1900 | 6.8 | .2 | .3 | .3 | – | 2.0 | 9.6 |
| 1910 | 12.7 | 1.0 | .5 | .5 | – | 1.9 | 16.6 |
| 1920 | 15.5 | 2.6 | .8 | .8 | – | 1.6 | 21.3 |
| 1930 | 13.6 | 5.4 | 2.0 | .8 | – | 1.5 | 23.3 |
| 1940 | 12.5 | 7.5 | 2.7 | .9 | – | 1.4 | 25.0 |
| 1950 | 12.9 | 13.5 | 6.2 | 1.4 | – | 1.2 | 35.2 |
| 1960 | 10.1 | 20.1 | 12.7 | 1.7 | – | – | 44.6 |
| 1970 | 12.7 | 29.5 | 22.0 | 2.7 | .2 | – | 67.1 |
| 1971 | 12.0 | 30.6 | 22.8 | 2.9 | .4 | – | 68.7 |
| 1972 | 12.4 | 33.0 | 23.0 | 2.9 | .6 | – | 71.9 |
| 1973 | 13.4 | 34.7 | 22.8 | 2.9 | .9 | – | 74.7 |
| 1974 | 13.0 | 33.8 | 22.3 | 2.9 | 1.2 | – | 73.2 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# U.S. Energy Consumption Trends, 1850-1974




Source: Historical Statistics of the United States, Bureau of the Census; U.S. Bureau of Mines.

# U.S. Energy Consumption Patterns

Fuel wood, which constituted 90.7 percent of U.S. energy sources in 1850, became a negligible energy source by 1960. As a percentage of total energy inputs, coal consumption reached its historical peak in 1910.

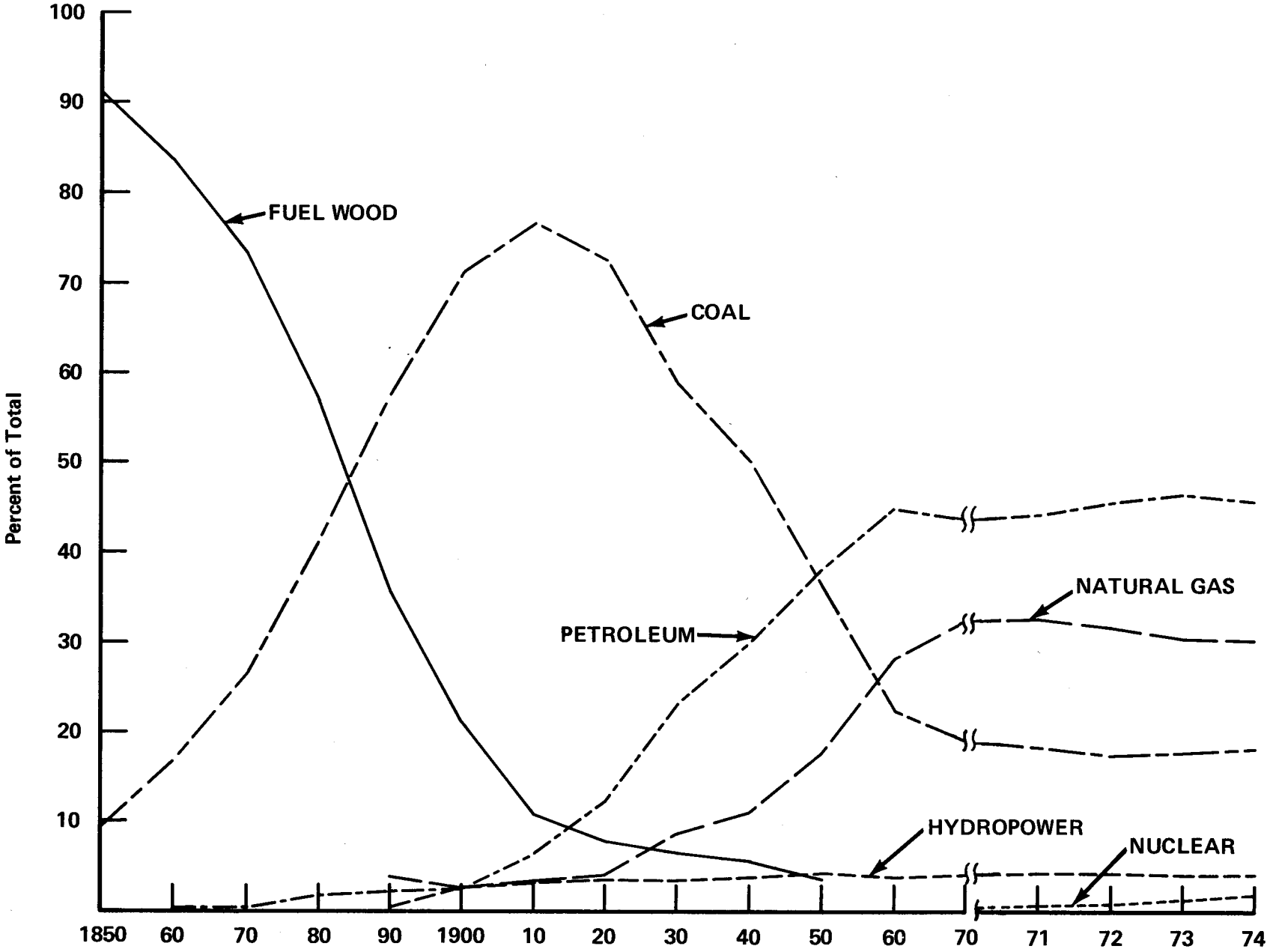
Between 1900 and 1974, petroleum increased its share of total energy consumption from 2.4 percent to 46.2 percent; natural gas increased its share from 2.6 percent to 30.4 percent; and coal's share of total energy inputs declined from 71.3 percent to 17.8 percent.

**U.S. Energy Consumption Patterns, 1850-1974**

**(Percent)**

| YEAR | COAL | PETROLEUM | NATURAL GAS | HYDROPOWER | NUCLEAR | FUEL WOOD |
|---|---|---|---|---|---|---|
| 1850 | 9.3 | – | – | – | – | 90.7 |
| 1860 | 16.4 | .1 | – | – | – | 83.5 |
| 1870 | 26.5 | .2 | – | – | – | 73.3 |
| 1880 | 41.1 | 1.9 | – | – | – | 57.0 |
| 1890 | 57.9 | 2.2 | 3.7 | .3 | – | 35.9 |
| 1900 | 71.3 | 2.4 | 2.6 | 2.6 | – | 21.1 |
| 1910 | 76.8 | 6.1 | 3.3 | 3.2 | – | 10.6 |
| 1920 | 72.8 | 12.2 | 3.9 | 3.6 | – | 7.5 |
| 1930 | 58.7 | 23.2 | 8.5 | 3.4 | – | 6.2 |
| 1940 | 50.1 | 30.0 | 10.9 | 3.7 | – | 5.3 |
| 1950 | 36.7 | 38.4 | 17.5 | 4.1 | – | 3.3 |
| 1960 | 22.8 | 45.0 | 28.5 | 3.7 | – | – |
| 1970 | 19.2 | 43.9 | 32.7 | 3.9 | .3 | – |
| 1971 | 18.2 | 44.2 | 32.9 | 4.1 | .6 | – |
| 1972 | 17.3 | 45.8 | 32.0 | 4.1 | .8 | – |
| 1973 | 17.8 | 46.5 | 30.5 | 4.0 | 1.2 | – |
| 1974 | 17.8 | 46.2 | 30.4 | 4.0 | 1.9 | – |

# U.S. Energy Consumption Patterns, 1850-1974




Source: Historical Statistics of the United States, Bureau of the Census; U.S. Bureau of Mines, 1974.

# U.S. Gross Energy Consumption Patterns

**[by Source]**

U.S. gross energy consumption increased at an annual rate of 3.6 percent during the 1960-74 period. Petroleum and natural gas gross energy consumption increased at annual rates of 3.8 and 4.1 percent during this period.

In 1974, petroleum and natural gas constituted 77 percent of gross energy consumption in the United States, while coal was 18 percent of the total.

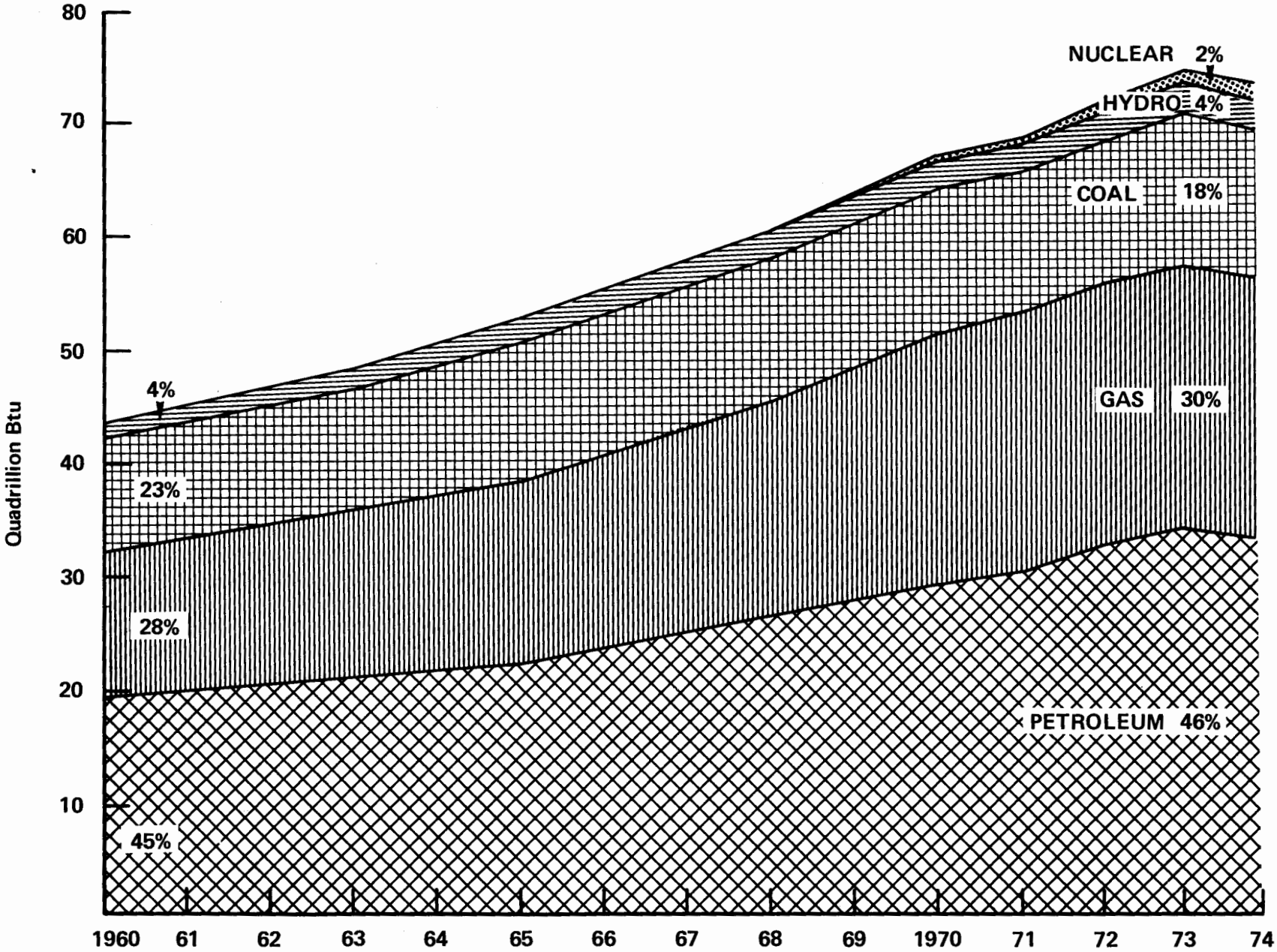
**U.S. Gross Energy Consumption Patterns By Source, 1960-74**

**(Quadrillion Btu)[1]**

| YEAR | PETROLEUM | NATURAL GAS | COAL | NUCLEAR | HYDROPOWER | TOTAL |
|---|---|---|---|---|---|---|
| 1960 | 20.1 | 12.7 | 10.1 | – | 1.7 | 44.6 |
| 1963 | 22.0 | 14.8 | 10.7 | – | 1.8 | 49.3 |
| 1965 | 23.2 | 16.1 | 11.9 | – | 2.1 | 53.3 |
| 1968 | 27.1 | 19.6 | 12.7 | .1 | 2.3 | 61.8 |
| 1970 | 29.5 | 22.0 | 12.7 | .2 | 2.7 | 67.1 |
| 1971 | 30.6 | 22.8 | 12.0 | .4 | 2.9 | 68.7 |
| 1972 | 33.0 | 23.0 | 12.4 | .6 | 2.9 | 71.9 |
| 1973 | 34.7 | 22.8 | 13.4 | .9 | 2.9 | 74.7 |
| 1974 | 33.8 | 22.3 | 13.0 | 1.2 | 2.9 | 73.2 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# U.S. Gross Energy Consumption Patterns By Source, 1960-74




Source: U.S. Bureau of Mines, 1975.

# U.S. Gross Energy Consumption

## [by Sector]

During the 1960-73 period, gross energy consumption in the electrical sector, increased at an annual rate of 6.9 percent.

Gross energy consumption in the transportation, industrial, and household and commercial sectors increased at annual rates of 4.3, 3.1, and 2.9 percent during this period.

### U.S. Gross Energy Consumption, By Sector, 1960-73

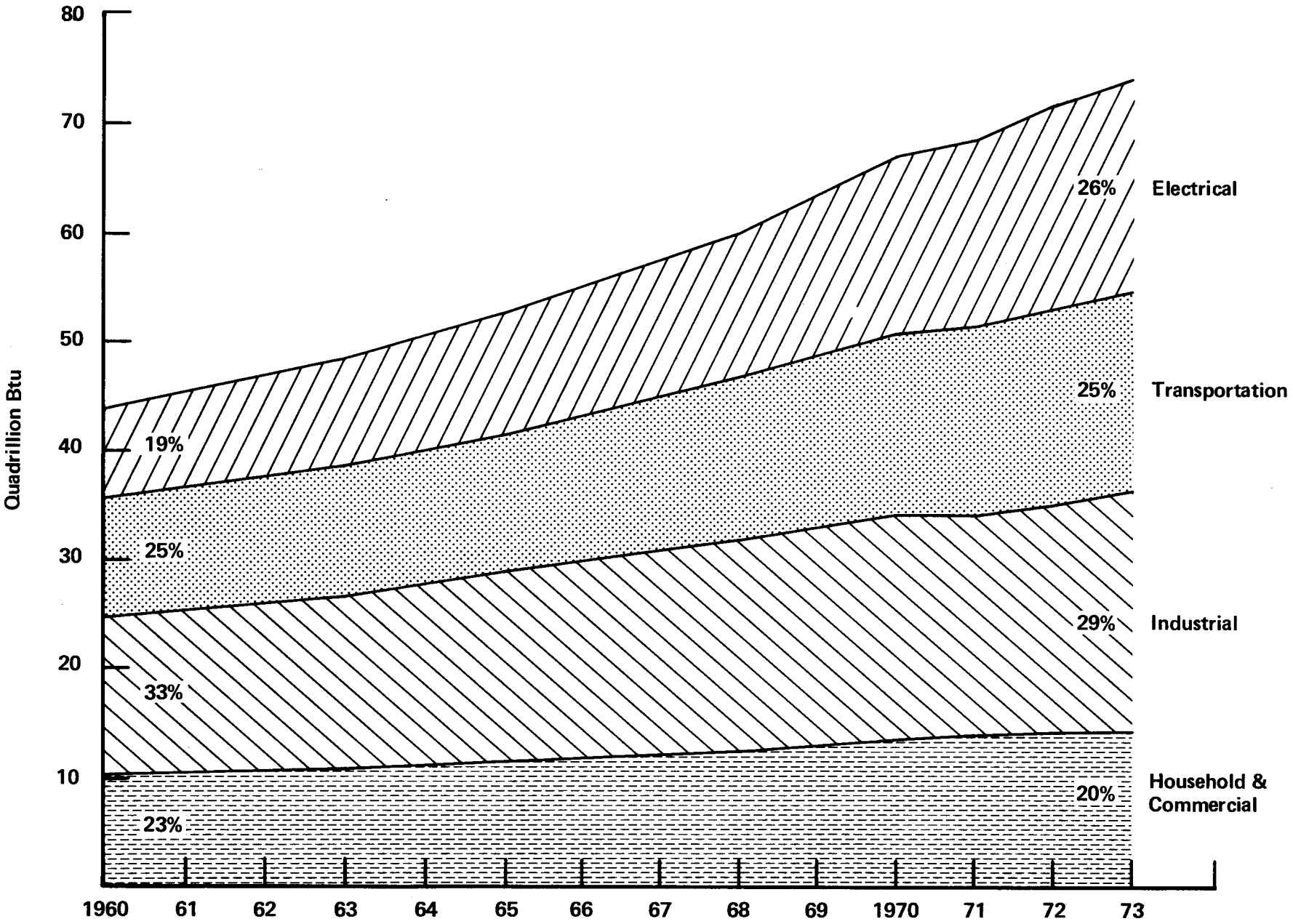
(Quadrillion Btu)[1]

| YEAR | HOUSEHOLD & COMMERCIAL | INDUSTRIAL | TRANSPORTATION | ELECTRICAL | TOTAL |
|---|---|---|---|---|---|
| 1960 | 10.2 | 16.6 | 10.8 | 8.3 | 44.6 |
| 1963 | 11.0 | 17.7 | 12.0 | 9.7 | 49.3 |
| 1965 | 13.1 | 19.5 | 12.7 | 11.1 | 53.3 |
| 1968 | 12.9 | 19.1 | 15.3 | 13.9 | 61.8 |
| 1970 | 14.0 | 20.4 | 16.5 | 16.2 | 67.1 |
| 1971 | 14.2 | 20.2 | 17.0 | 17.3 | 68.7 |
| 1972 | 14.6 | 20.7 | 18.0 | 18.6 | 71.9 |
| 1973 | 14.7 | 21.7 | 18.6 | 19.7 | 74.7 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

Note.—Gross consumption of energy refers to the total energy consumption of the economy; net energy refers to the energy used by the final consuming sectors, and does not include the losses experienced in converting primary sources to secondary sources.

# U.S. Gross Energy Consumption, by Sector, 1960-73




Source: U.S. Bureau of Mines, 1974.

# U.S. Energy Consumption

**(Per Capita)**

Per capita energy consumption in the United States increased 1.4 percent annually since 1900.

Per capita energy consumption increased 1.8 percent annually since 1950, and at a 2.6-percent annual rate since 1970.

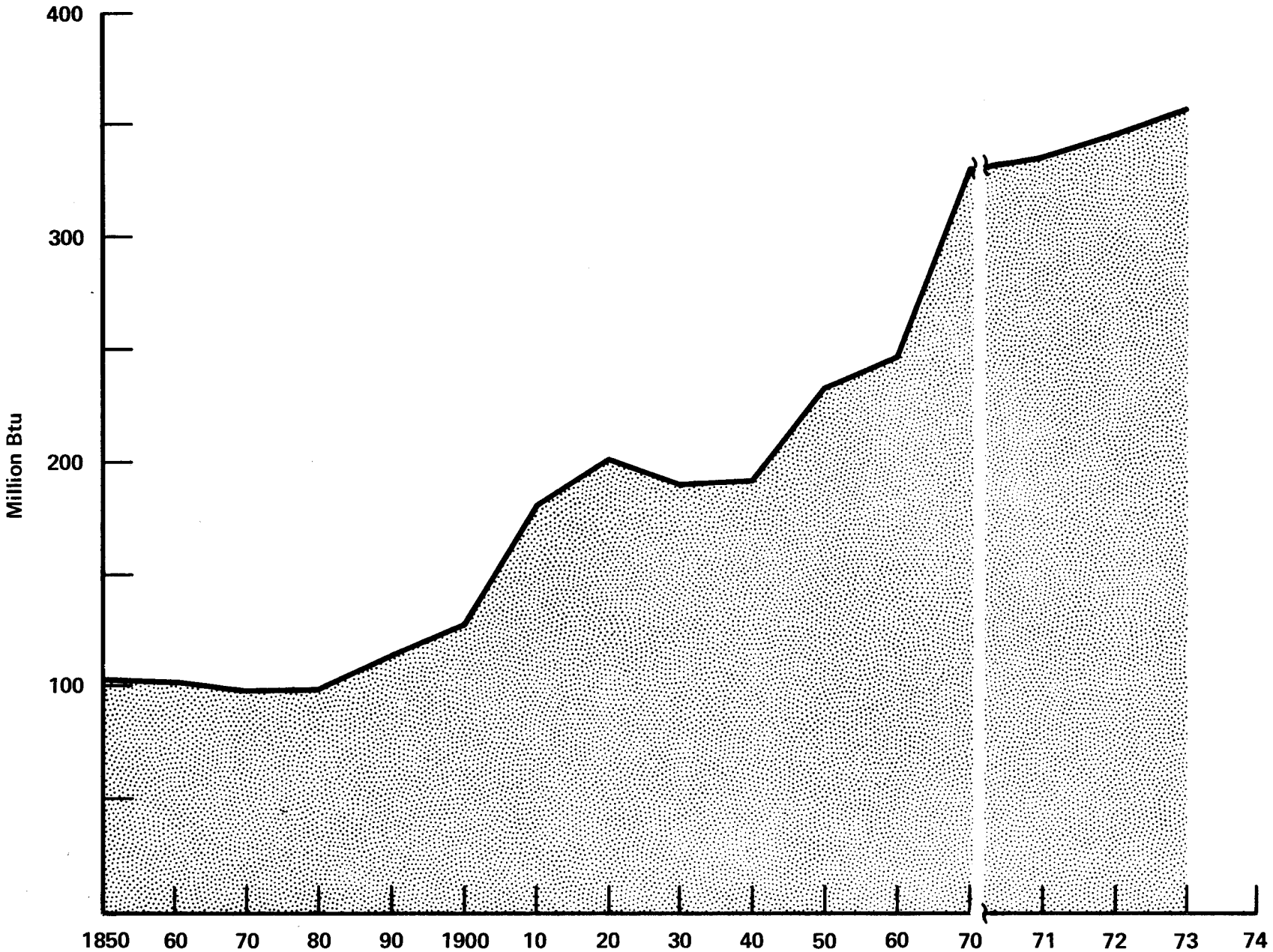
**U.S. Energy Consumption, Per Capita, 1850-1973**

**(Millions of Btu)[1]**

| YEAR | AMOUNT | YEAR | AMOUNT |
|---|---|---|---|
| 1850 | 101.2 | 1930 | 188.6 |
| 1860 | 100.4 | 1940 | 189.4 |
| 1870 | 99.0 | 1950 | 231.7 |
| 1880 | 99.4 | 1960 | 246.6 |
| 1890 | 111.1 | 1970 | 329.3 |
| 1900 | 125.9 | 1971 | 333.4 |
| 1910 | 174.3 | 1972 | 344.6 |
| 1920 | 200.1 | 1973 | 355.1 |

[1] 100 million Btu = 18 barrels of petroleum equivalent.

# U.S. Energy Consumption, Per Capita, 1850-1973




Source: Historical Statistics of the U.S., U.S. Bureau of the Census; U.S. Bureau of Mines.

# U.S. Net Energy Consumption

## [by Final Consuming Sector]

During the 1960-73 period, total U.S. net energy consumption[1] increased at an annual rate of 3.7 percent. Consumption in the industrial sector increased at an annual rate of 3.3 percent; in the transportation sector, 4.3 percent annually; and in the household and commercial sector, 3.8 percent.

### U.S. Net Energy Consumption, By Final Consuming Sector, 1960-73

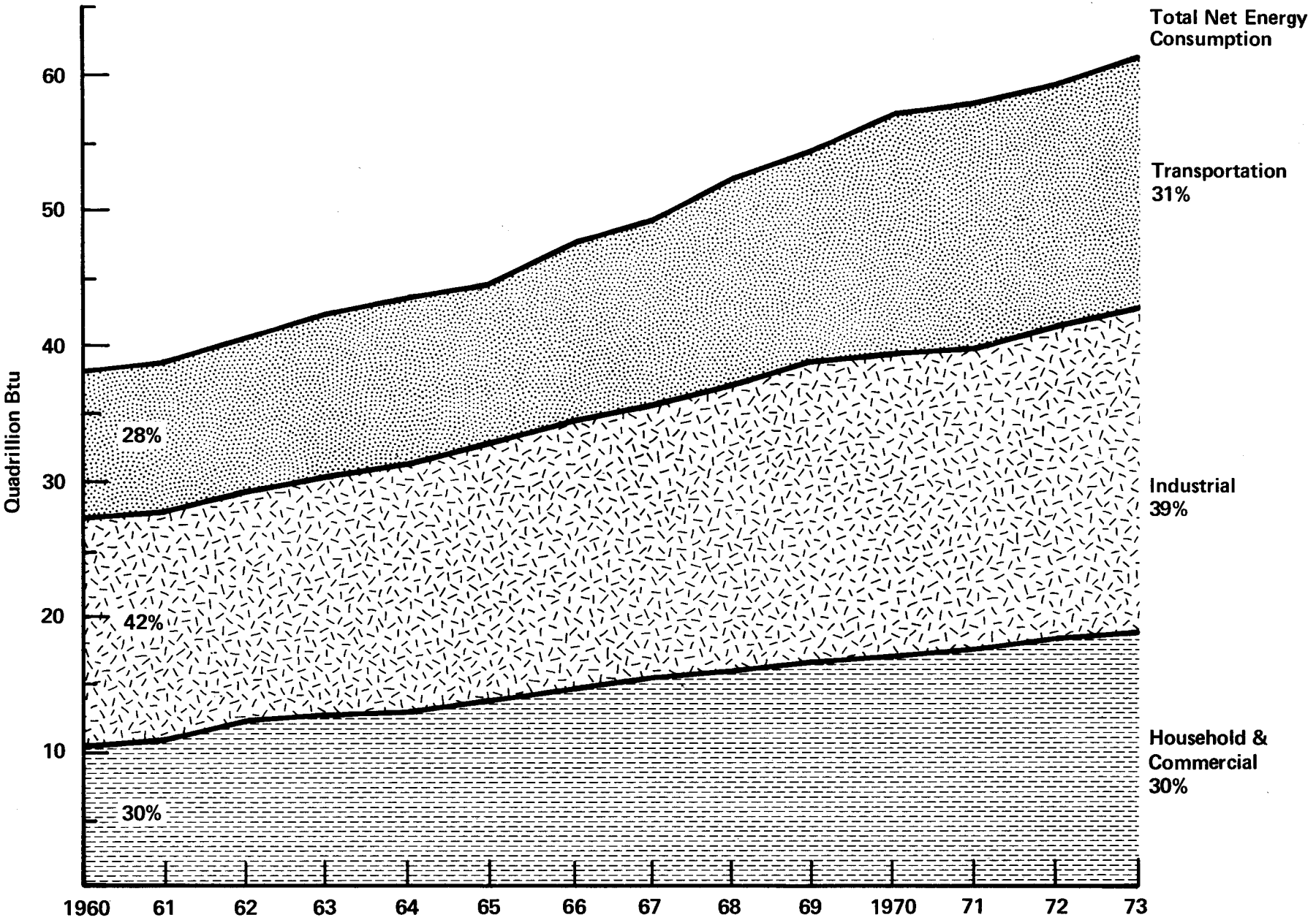
(Quadrillion Btu)[1]

| YEAR | HOUSEHOLD & COMMERCIAL | INDUSTRIAL | TRANSPORTATION | TOTAL |
|---|---|---|---|---|
| 1960 | 11.4 | 15.9 | 10.8 | 38.1 |
| 1961 | 11.8 | 15.9 | 11.0 | 38.7 |
| 1962 | 12.4 | 16.7 | 11.4 | 40.5 |
| 1963 | 12.7 | 17.4 | 12.0 | 41.0 |
| 1964 | 12.9 | 18.2 | 12.3 | 43.4 |
| 1965 | 13.8 | 18.8 | 12.7 | 45.3 |
| 1966 | 14.5 | 19.8 | 13.4 | 47.7 |
| 1967 | 15.3 | 20.1 | 14.0 | 49.4 |
| 1968 | 15.6 | 21.4 | 15.2 | 52.2 |
| 1969 | 16.4 | 22.3 | 15.8 | 54.5 |
| 1970 | 17.0 | 22.6 | 16.5 | 56.1 |
| 1971 | 17.4 | 22.5 | 17.1 | 57.0 |
| 1972 | 18.1 | 23.3 | 18.0 | 59.4 |
| 1973 | 18.4 | 24.2 | 18.8 | 61.4 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

[1] Net energy refers to the energy used by the final consuming sectors, and does not include the losses experienced in converting primary to secondary sources.

# U.S. Net Energy Consumption, by Final Consuming Sector, 1960-73




Source: U.S. Bureau of Mines, 1974.

# U.S. Net Energy Consumption

## [Residential and Commercial Sectors]

In 1970, total net energy consumption[1] for residential end uses in the United States was 52 percent greater than for commercial end uses.

Space heating was the dominant end use in both the residential and commercial sectors, accounting for slightly more than two-thirds of total net energy consumption in both sectors.

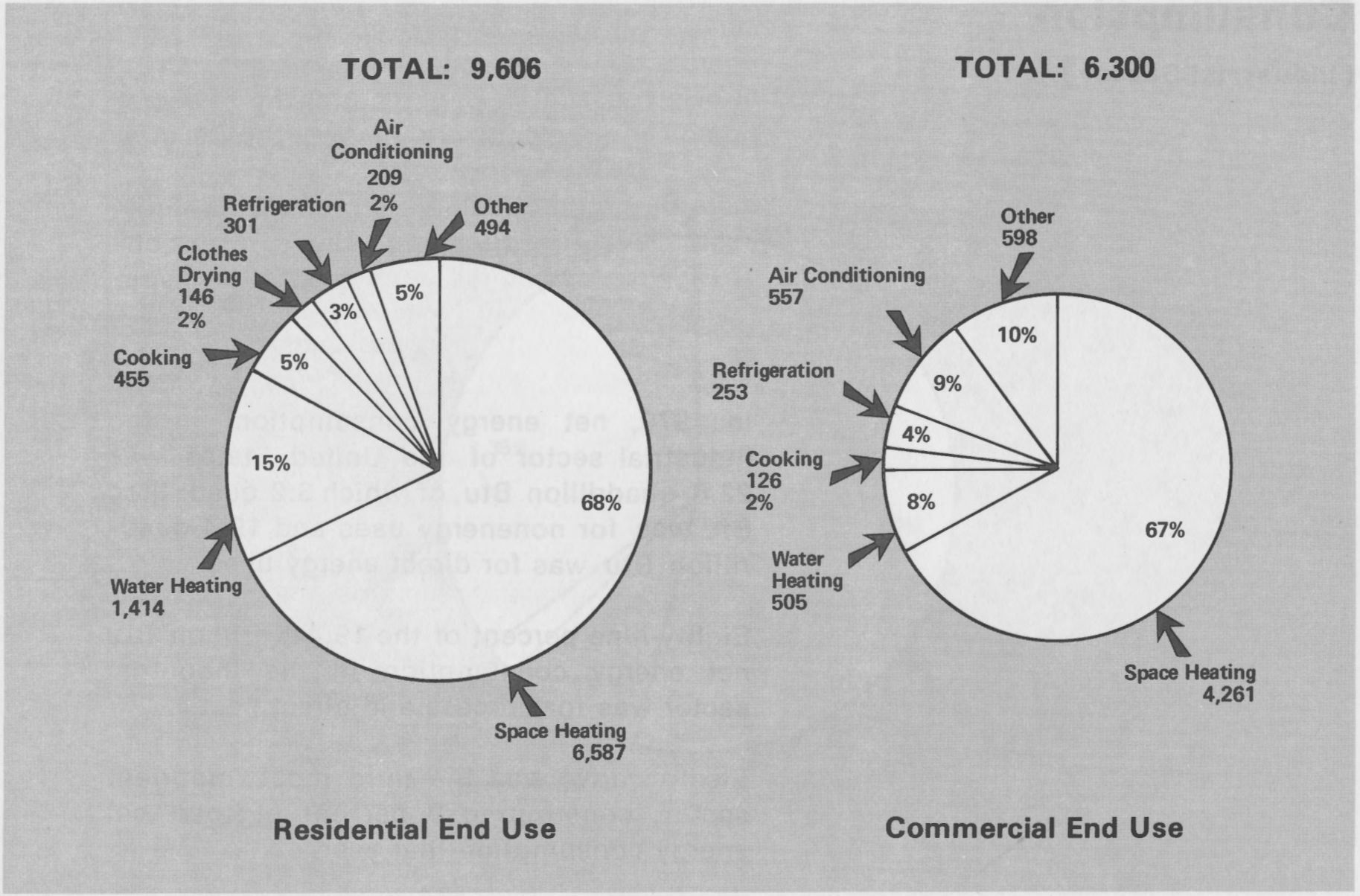
Air conditioning constituted 9 percent of commercial net energy consumption in 1970, but only 2 percent of residential net energy consumption.

In 1970, net energy consumption in the residential and commercial sectors represented 17 and 11 percent, respectively, of total net energy consumption in the United States.

[1] Net energy refers to the energy used by the final consuming sectors, and does not include the losses experienced in converting primary to secondary sources.

# U.S. Net Energy Consumption, Residential and Commercial Sectors, 1970

(Trillion Btu)[1]




Note.--Does not include nonenergy uses.

[1] 1 Quadrillion Btu = 1,000 trillion Btu.

Source: U.S. Bureau of Mines, 1973.

# U.S. Net Energy Consumption

## [Industrial Sector]

In 1970, net energy consumption[1] in the industrial sector of the United States was 22.6 quadrillion Btu, of which 3.2 quadrillion Btu was for nonenergy uses and 19.4 quadrillion Btu was for direct energy uses.

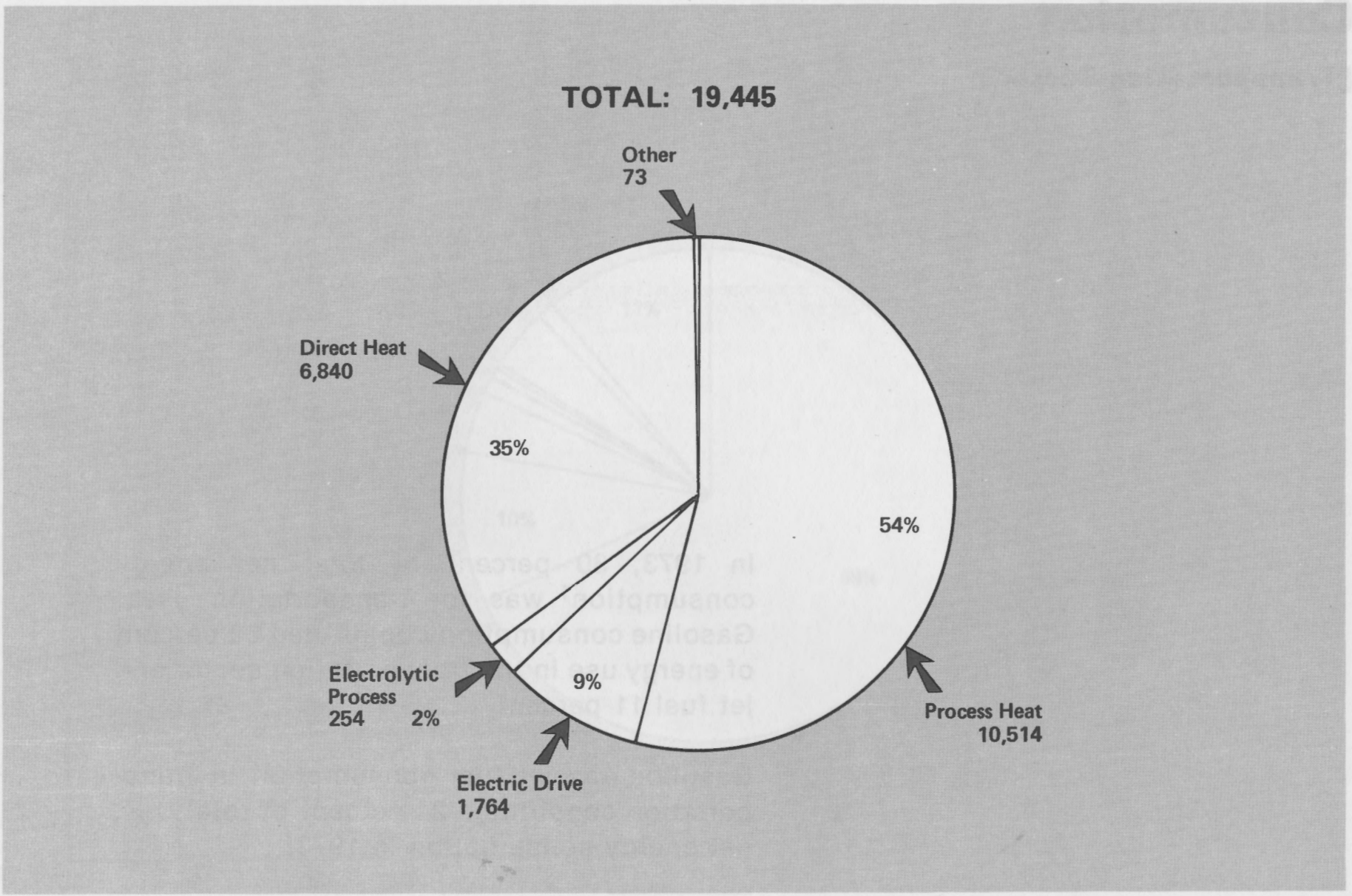
Eighty-nine percent of the 19,445 trillion Btu net energy consumption in the industrial sector was for process and direct heat.

Electric drive was the third most important sector, constituting 9 percent of total net energy consumption that year.

[1] Net energy refers to the energy used by the final consuming sectors, and does not include the losses experienced in converting primary to secondary sources.

# U.S. Net Energy Consumption, Industrial Sector, 1970

(Trillion Btu)[1]




Note.—Nonenergy uses not shown.

[1] 1 Quadrillion Btu = 1,000 trillion Btu.

Source: U.S. Bureau of Mines, 1973.

# U.S. Net Energy Consumption

## [Transportation Sector]

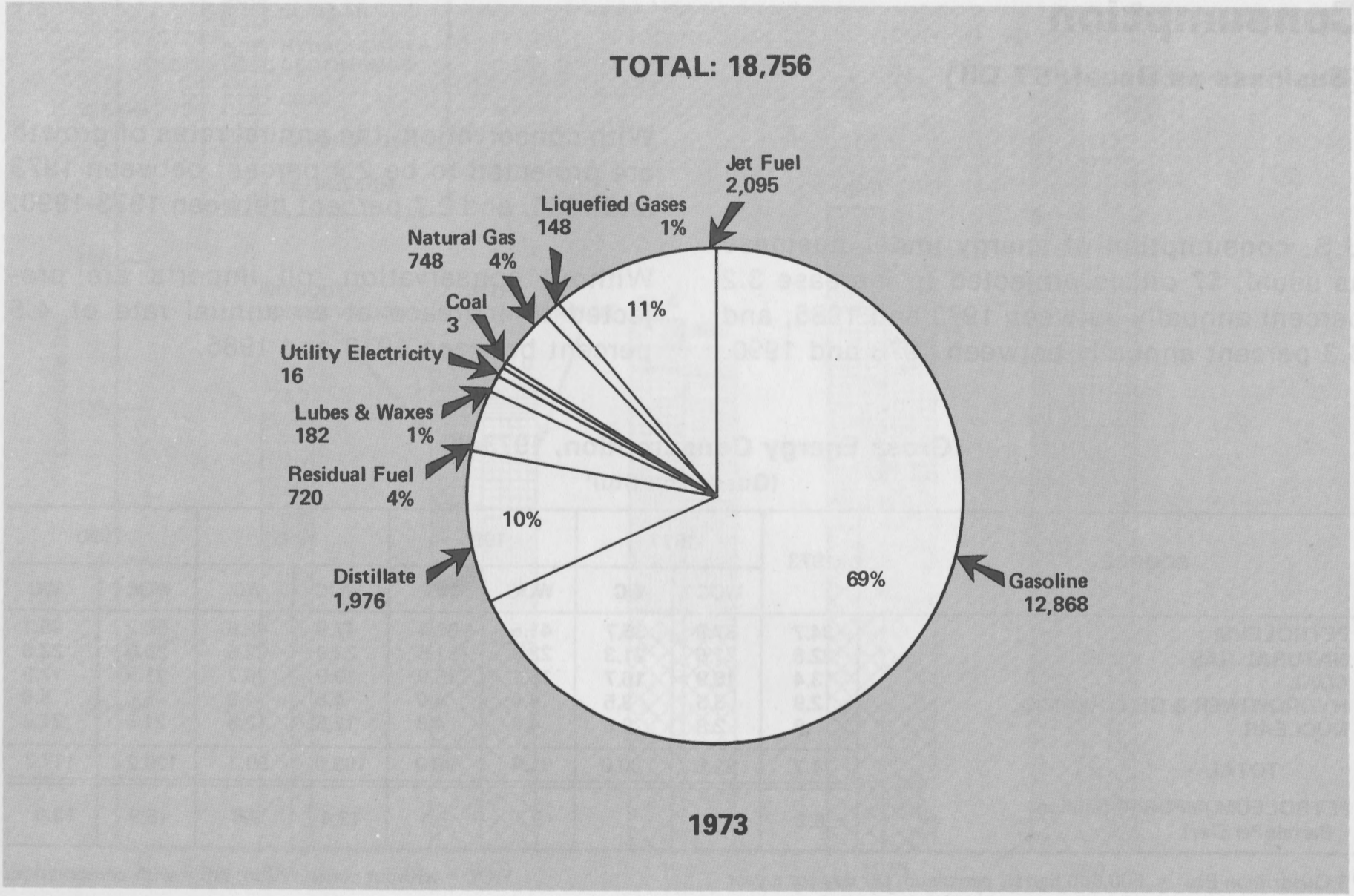
In 1973, 30 percent of total net energy consumption[1] was for transportation uses. Gasoline consumption constituted 69 percent of energy use in the transportation sector and jet fuel 11 percent.

Gasoline and jet fuel consumption in transportation constituted 24 percent of total U.S. net energy consumption in 1973.

[1] Net energy refers to the energy used by the final consuming sectors, and does not include the losses experienced in converting primary to secondary sources.

# U.S. Net Energy Consumption, Transportation Sector, 1973

(Trillion Btu)[1]




[1] 1 Quadrillion Btu = 1,000 trillion.

Source: U.S. Bureau of Mines, 1974.

# U.S. Gross Energy Consumption

**[Business as Usual, $7 Oil]**

U.S. consumption of energy under business as usual, $7 oil, is projected to increase 3.2 percent annually between 1973 and 1985, and 3.3 percent annually between 1973 and 1990.

With conservation, the annual rates of growth are projected to be 2.4 percent between 1973 and 1985, and 2.7 percent between 1973-1990.

Without conservation, oil imports are projected to increase at an annual rate of 4.5 percent between 1973 and 1985.

## Gross Energy Consumption, 1973-90

**(Quadrillion Btu)[1]**

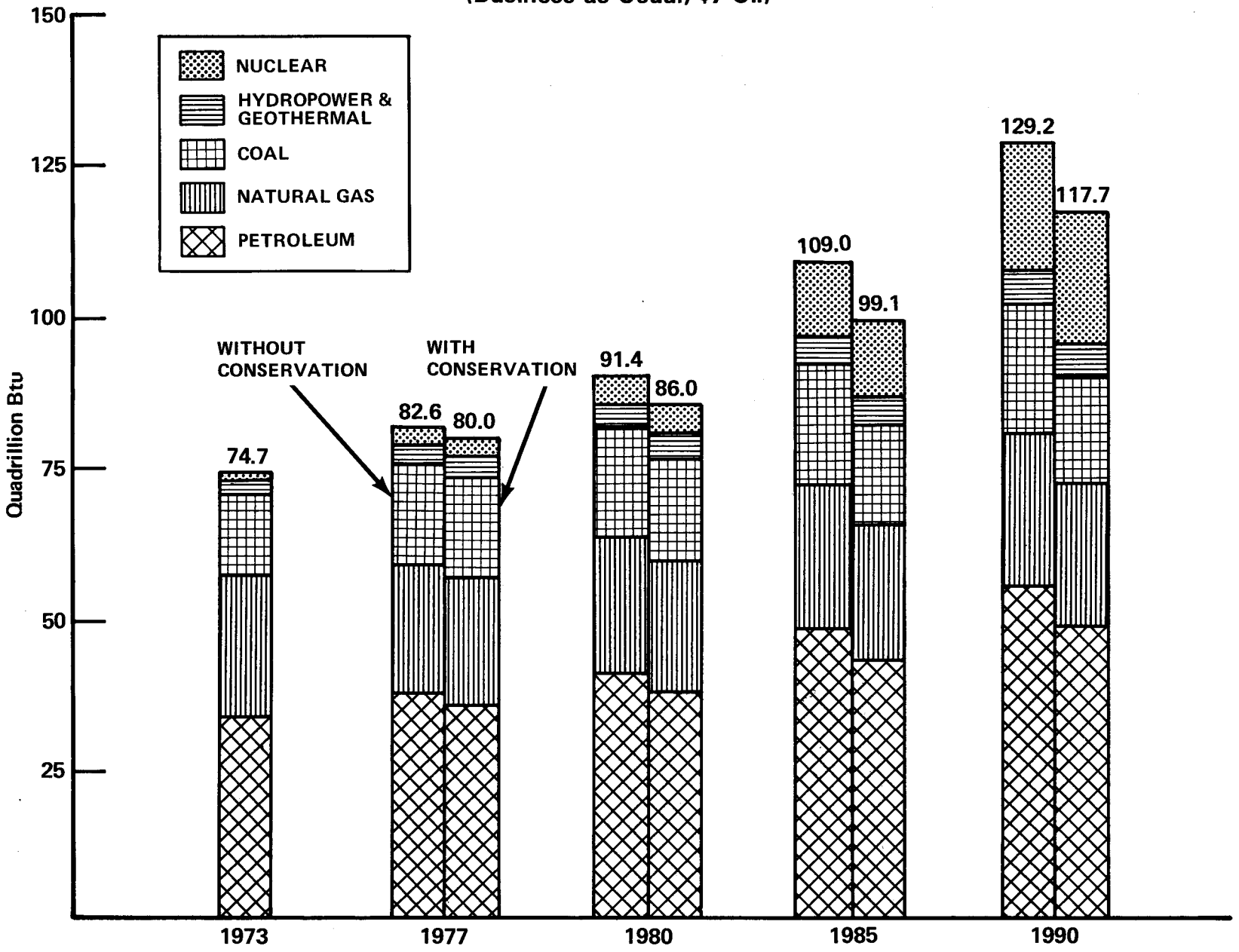
| SOURCE | 1973 | 1977 | | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 34.7 | 37.8 | 35.7 | 41.6 | 38.4 | 47.9 | 42.6 | 55.2 | 49.1 |
| NATURAL GAS | 22.8 | 21.6 | 21.3 | 22.9 | 21.9 | 23.9 | 22.5 | 25.0 | 23.6 |
| COAL | 13.4 | 16.9 | 16.7 | 18.1 | 16.9 | 19.9 | 16.7 | 21.9 | 17.9 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 3.5 | 3.5 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 2.8 | 2.8 | 4.8 | 4.8 | 12.5 | 12.5 | 21.5 | 21.5 |
| TOTAL | 74.7 | 82.6 | 80.0 | 91.4 | 86.0 | 109.0 | 99.1 | 129.2 | 117.7 |
| PETROLEUM IMPORTS (Million Barrels Per Day) | 6.2 | | | 9.7 | 8.1 | 12.4 | 9.8 | 15.9 | 13.0 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

WOC = without conservation; WC = with conservation.

# U.S. Gross Energy Consumption, 1973-90

(Business as Usual, $7 Oil)




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# U.S. Gross Energy Consumption

**[Business as Usual, $11 Oil]**

Gross consumption of energy in the United States, given business as usual, $11 oil, is projected to increase 2.7 percent annually between 1973 and 1985, and 2.9 percent annually between 1973 and 1990.

With conservation, the annual rates of growth are estimated at 2.0 percent for 1973-85 and 2.4 percent for 1973-90.

The following table presents the changes in the consumption mix and imports of petroleum between 1973 and 1990.

## U.S. Gross Energy Consumption, 1973-90

**(Quadrillion Btu)[1]**

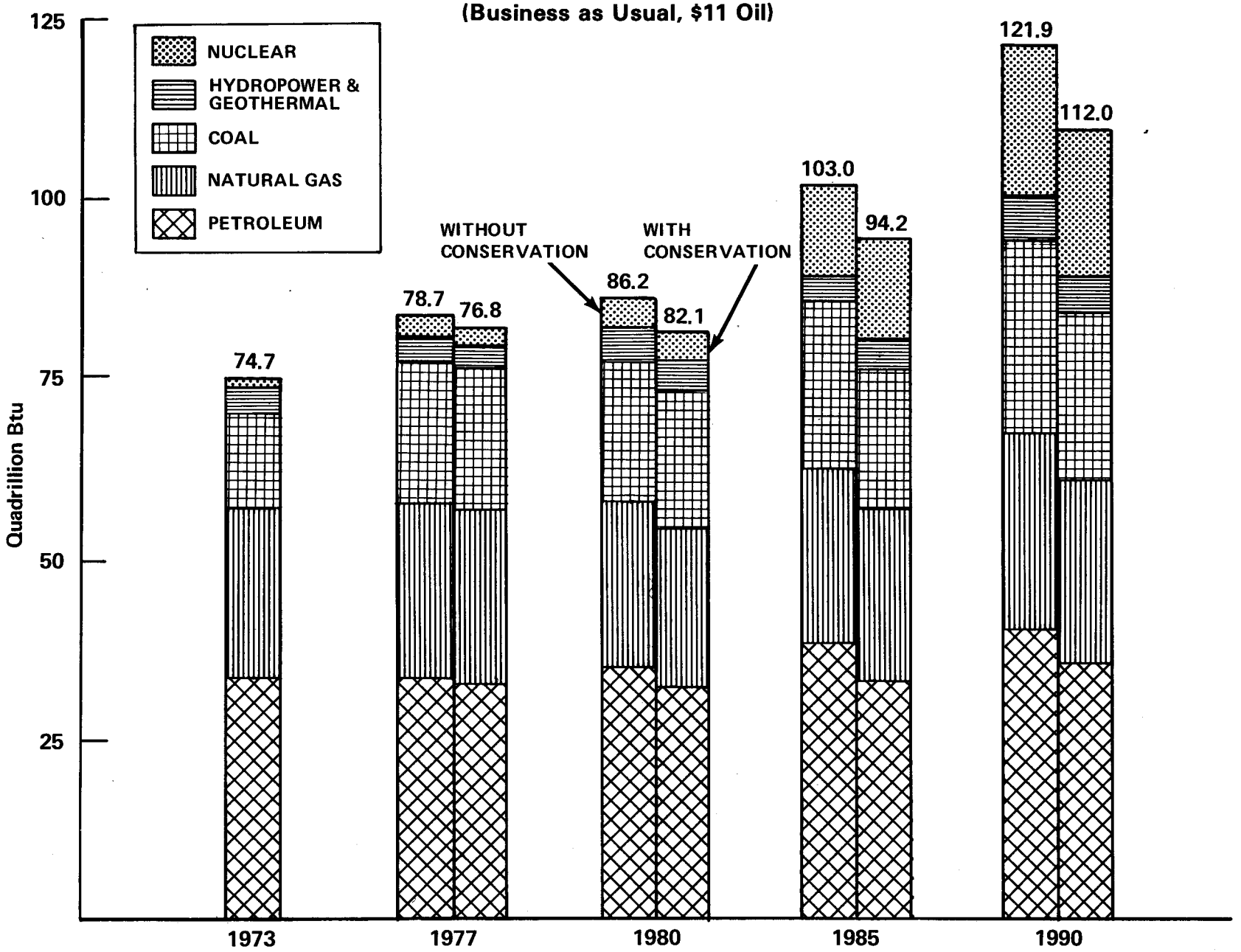
| SOURCE | 1973 | 1977 | | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 34.7 | 34.1 | 32.4 | 34.9 | 32.5 | 38.0 | 33.5 | 41.3 | 36.5 |
| NATURAL GAS | 22.8 | 21.7 | 21.7 | 23.1 | 22.2 | 24.8 | 23.7 | 26.6 | 25.2 |
| COAL | 13.4 | 16.6 | 16.4 | 19.4 | 18.6 | 22.9 | 19.7 | 26.9 | 23.2 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 3.5 | 3.5 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 2.8 | 2.8 | 4.8 | 4.8 | 12.5 | 12.5 | 21.5 | 21.5 |
| TOTAL | 74.7 | 78.7 | 76.8 | 86.2 | 82.1 | 103.0 | 94.2 | 121.9 | 112.0 |
| PETROLEUM IMPORTS (Million Barrels Per Day) | 6.2 | N/A | N/A | 4.6 | 3.3 | 3.3 | 1.2 | 3.9 | 1.8 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

WOC = without conservation; WC = with conservation.

# U.S. Gross Energy Consumption, 1973-90

(Business as Usual, $11 Oil)




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# U.S. Gross Energy Consumption

**[Accelerated Supply, $7 Oil]**

Consumption of energy under accelerated supply, $7 oil, is projected to increase 3.2 percent annually between 1973 and 1985, and 3.3 percent annually between 1973 and 1990.

With conservation, the annual rates of growth are projected at 2.4 percent to 1985, and 2.8 percent to 1990.

## U.S. Gross Energy Consumption, 1973-90

**(Quadrillion Btu)[1]**

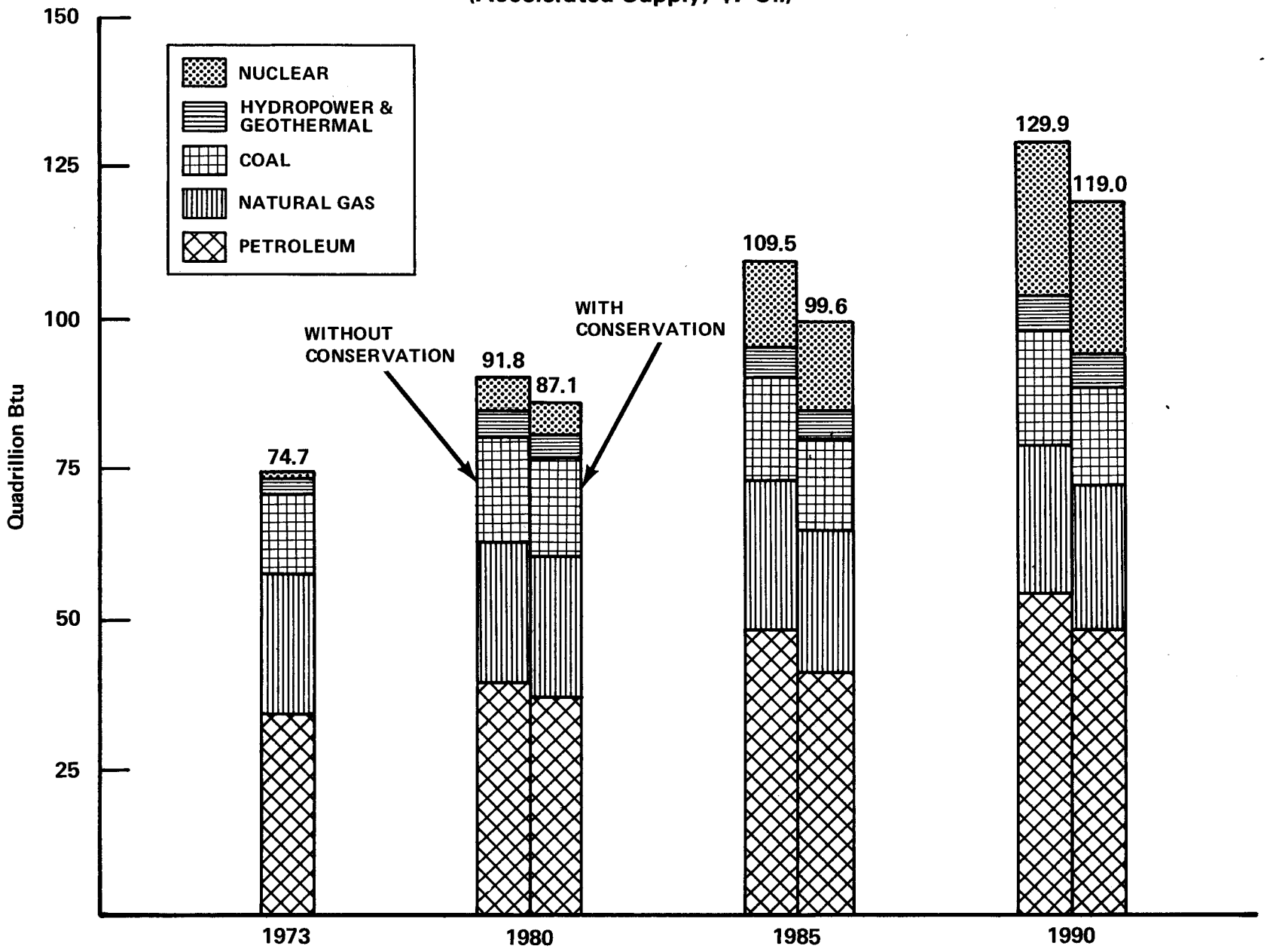
| SOURCE | 1973 | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 34.7 | 41.1 | 37.9 | 47.6 | 41.3 | 55.1 | 47.9 |
| NATURAL GAS | 22.8 | 23.6 | 23.1 | 24.7 | 23.6 | 25.9 | 24.7 |
| COAL | 13.4 | 17.4 | 16.4 | 17.7 | 15.2 | 18.0 | 15.5 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 5.7 | 5.7 | 14.7 | 14.7 | 25.3 | 25.3 |
| TOTAL | 74.7 | 91.8 | 87.1 | 109.5 | 99.6 | 129.9 | 119.0 |
| PETROLEUM IMPORTS (Million Barrels Per Day) | 6.2 | 8.4 | 6.8 | 8.5 | 5.6 | 12.0 | 8.7 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

WOC = without conservation; WC = with conservation.

# U.S. Gross Energy Consumption, 1973-90

**(Accelerated Supply, $7 Oil)**




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# U.S. Gross Energy Consumption

**[Accelerated Supply, $11 Oil]**

Consumption of energy under accelerated supply, $11 oil, is projected to increase 2.8 percent annually between 1973 and 1985, and 3.0 percent annually between 1973 and 1990.

With conservation the annual rates of growth are projected at 2.1 percent to 1985, and 2.6 percent to 1990.

Imports of oil are expected to decline from 6.2 million barrels a day in 1973 to zero by 1985, with or without conservation.

Without conservation, petroleum is estimated to provide 34 percent of total gross energy consumption in 1990 as compared to 46 percent in 1973.

**U.S. Gross Energy Consumption, 1973-90**

**(Quadrillion Btu)[1]**

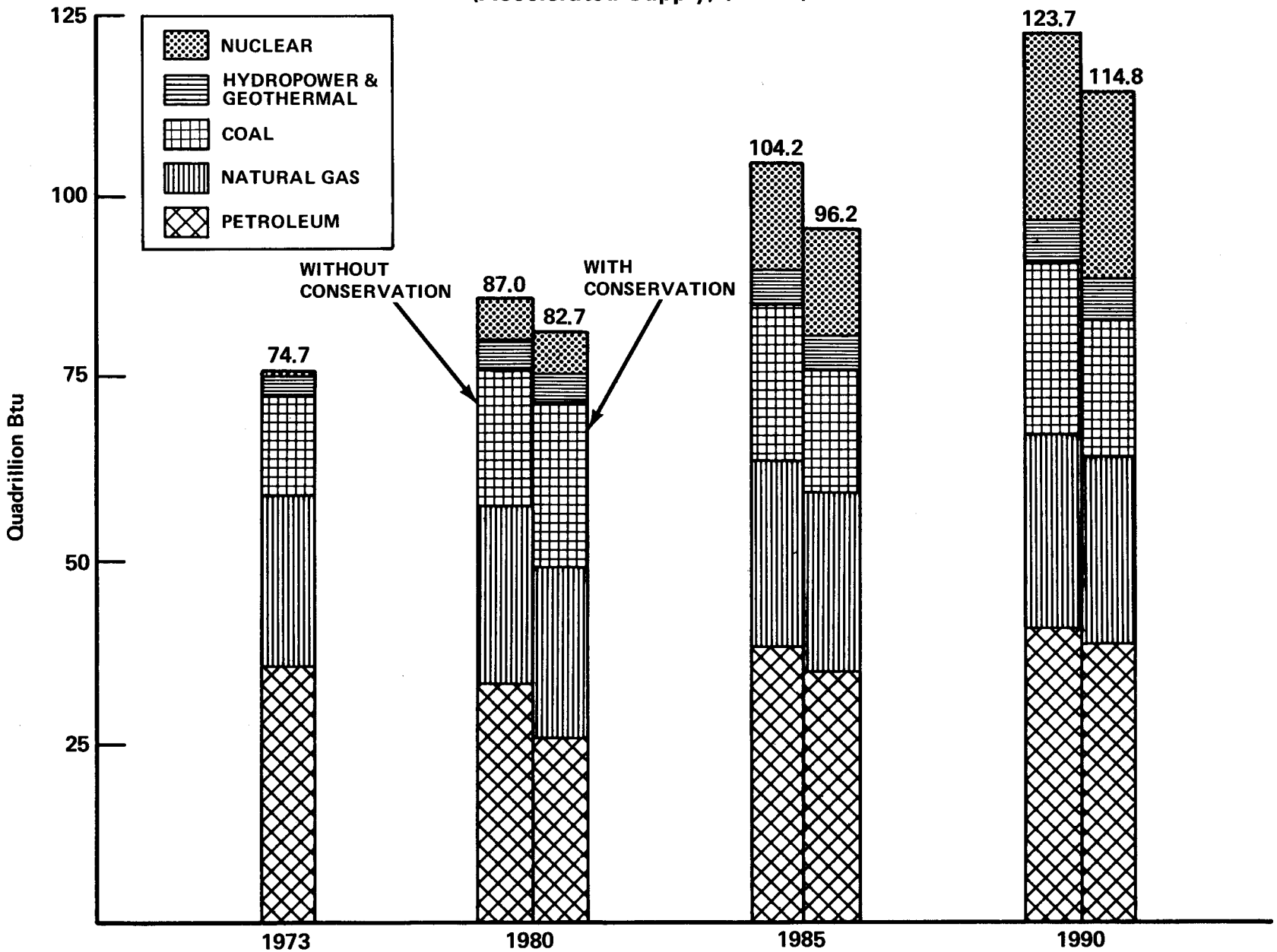
| SOURCE | 1973 | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 34.7 | 34.2 | 32.2 | 38.1 | 35.7 | 42.4 | 39.6 |
| GAS | 22.8 | 24.2 | 23.5 | 25.5 | 24.6 | 26.9 | 25.9 |
| COAL | 13.4 | 18.9 | 17.3 | 21.1 | 16.4 | 23.5 | 18.4 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 5.7 | 5.7 | 14.7 | 14.7 | 25.3 | 25.3 |
| TOTAL | 74.7 | 87.0 | 82.7 | 104.2 | 96.2 | 123.7 | 114.8 |
| PETROLEUM IMPORTS (Million Barrels Per Day) | 6.2 | 2.9 | 2.0 | 0 | 0 | 0 | 0 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

WOC = without conservation; WC = with conservation.

# U.S. Gross Energy Consumption, 1973-90

(Accelerated Supply, $11 Oil)




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# Cumulative U.S. Gross Energy Consumption Projections

During the 1973-90 period, cumulative gross energy consumption in the United States will be 5 percent lower if $11 oil rather than $7 oil prevails for both business as usual without conservation and accelerated supply without conservation.

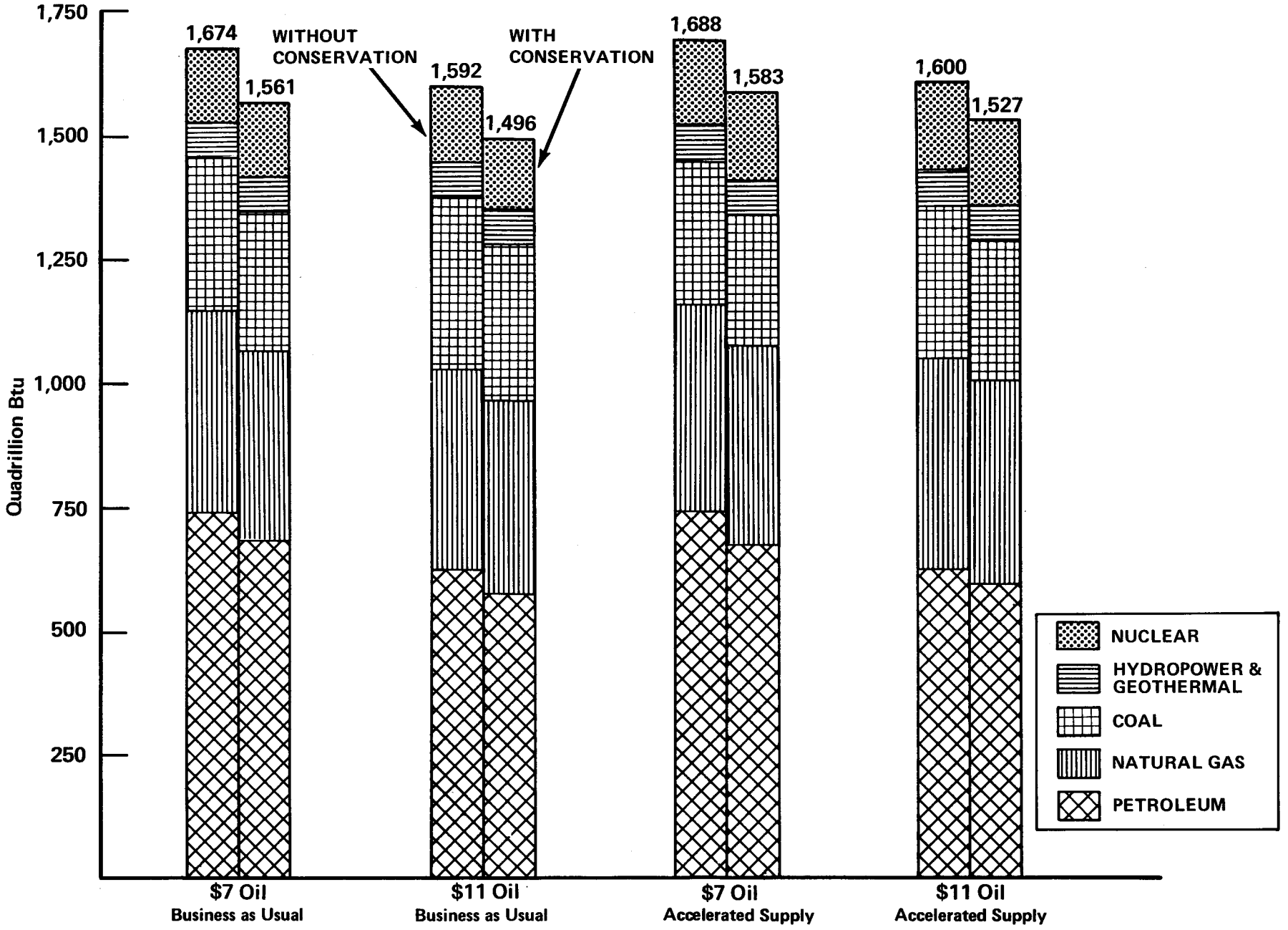
## Cumulative U.S. Gross Energy Consumption Projections

(Quadrillion Btu)[1]

| SOURCE | BUSINESS AS USUAL | | | | ACCELERATED SUPPLY | | | |
|---|---|---|---|---|---|---|---|---|
| | WITH CONSERVATION | | WITHOUT CONSERVATION | | WITH CONSERVATION | | WITHOUT CONSERVATION | |
| | $7 OIL | $11 OIL | $7 OIL | $11 OIL | $7 OIL | $11 OIL | $7 OIL | $11 OIL |
| PETROLEUM | 683 | 571 | 746 | 622 | 675 | 592 | 744 | 623 |
| GAS | 380 | 392 | 396 | 407 | 401 | 410 | 413 | 422 |
| COAL | 280 | 315 | 314 | 345 | 261 | 279 | 285 | 309 |
| HYDROPOWER & GEOTHERMAL | 72 | 72 | 72 | 72 | 72 | 72 | 72 | 72 |
| NUCLEAR | 146 | 146 | 146 | 146 | 174 | 174 | 174 | 174 |
| TOTAL | 1,561 | 1,496 | 1,674 | 1,592 | 1,583 | 1,527 | 1,688 | 1,600 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# Cumulative U.S. Gross Energy Consumption Projections, 1973-90




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# Efficiency of Energy Utilization

**[Business as Usual, $11 Oil]**

Given business as usual, $11 oil, it is projected that efficently used energy in the United States will increase at an annual rate of 2.1 percent between 1972 and 1985. Lost energy[1] is expected to increase at an annual rate of 3.4 percent during this period. Thus, efficiency of energy utilization will decline in comparison to the 1960-72 period. Much of the decline in efficiency can be attributed to the increased use of electricity with resultant conversion losses.

**Efficiency of Energy Utilization, 1960-85**

**(Quadrillion Btu)[1]**

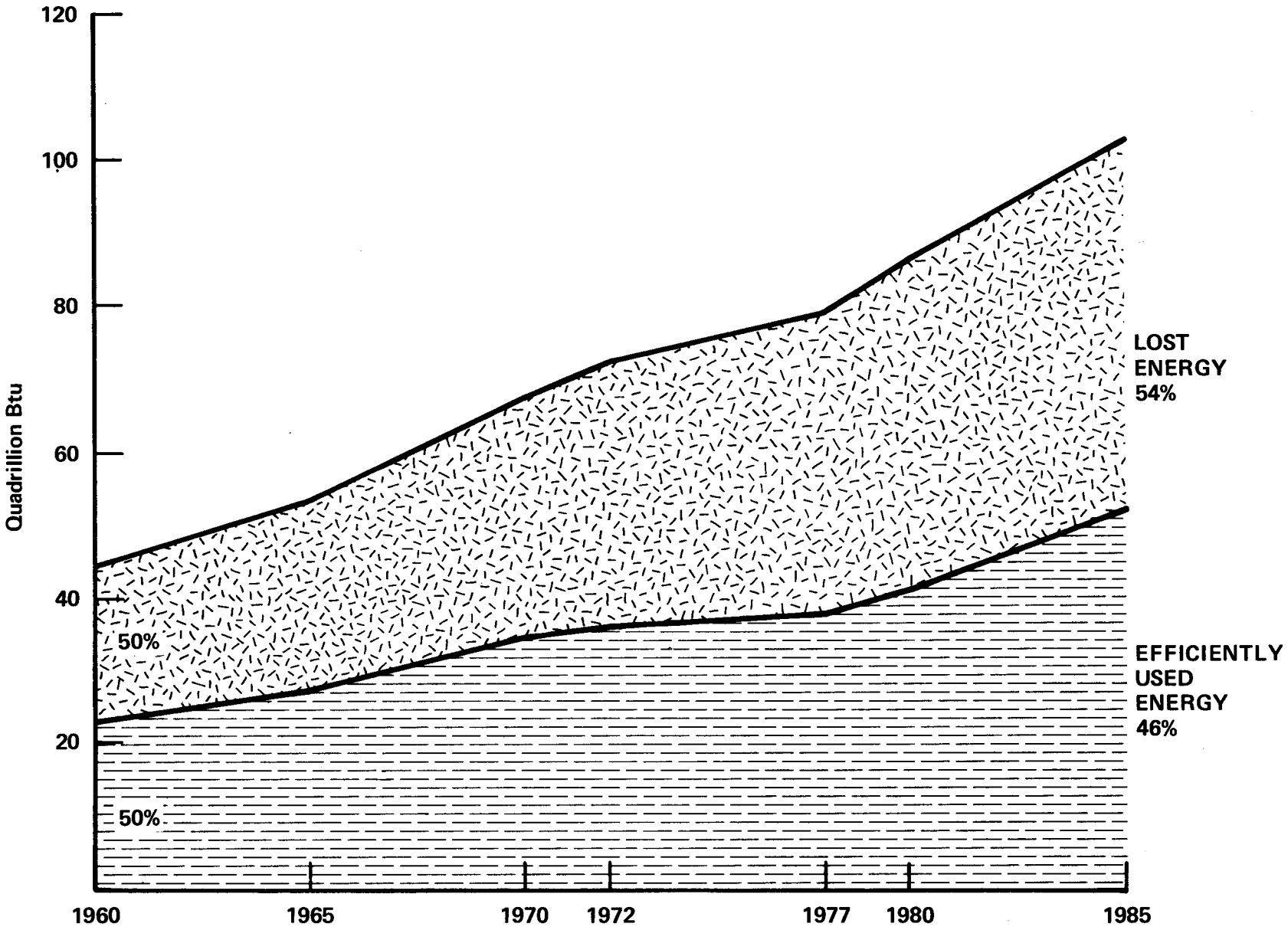
| YEAR | TOTAL ENERGY INPUTS | EFFICIENTLY USED ENERGY | LOST ENERGY |
|---|---|---|---|
| 1960 | 44.4 | 22.1 | 22.3 |
| 1965 | 53.5 | 27.3 | 26.2 |
| 1970 | 67.5 | 34.2 | 33.3 |
| 1972 | 72.1 | 36.0 | 36.1 |
| 1977 | 78.9 | 37.9 | 41.0 |
| 1980 | 86.3 | 41.1 | 45.2 |
| 1985 | 102.9 | 47.1 | 55.8 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

[1] Lost energy refers to the total losses in all energy-using devices including heating, cooling, transportation and electricity production.

# Efficiency of Energy Utilization, 1960-85

**(Business as Usual, $11 Oil)**




Source: U.S. Department of the Interior, 1974.

# Efficiency of Energy Utilization

**[Business as Usual, $7 Oil]**

During the 1960-72 period, only half of total energy produced in the United States was efficiently used.

While total energy inputs are projected to increase at an annual rate of 3.2 percent during the 1972-1985 period, under business as usual, $7 oil, efficiently used energy is projected to increase at an annual rate of 2.5 percent, while lost energy[1] will increase at a 3.9 percent annual rate. Decreased efficiency in the use of energy is therefore projected for the United States.

In 1985, given business as usual, $7 oil, 55 percent of total energy will be lost as compared to a 50-percent lost ratio in 1960. Much of the decline in efficiency can be attributed to the increased use of electricity, with resultant losses in the conversion process.

**Efficiency of Energy Utilization, 1960-85 (Quadrillion Btu)[1]**

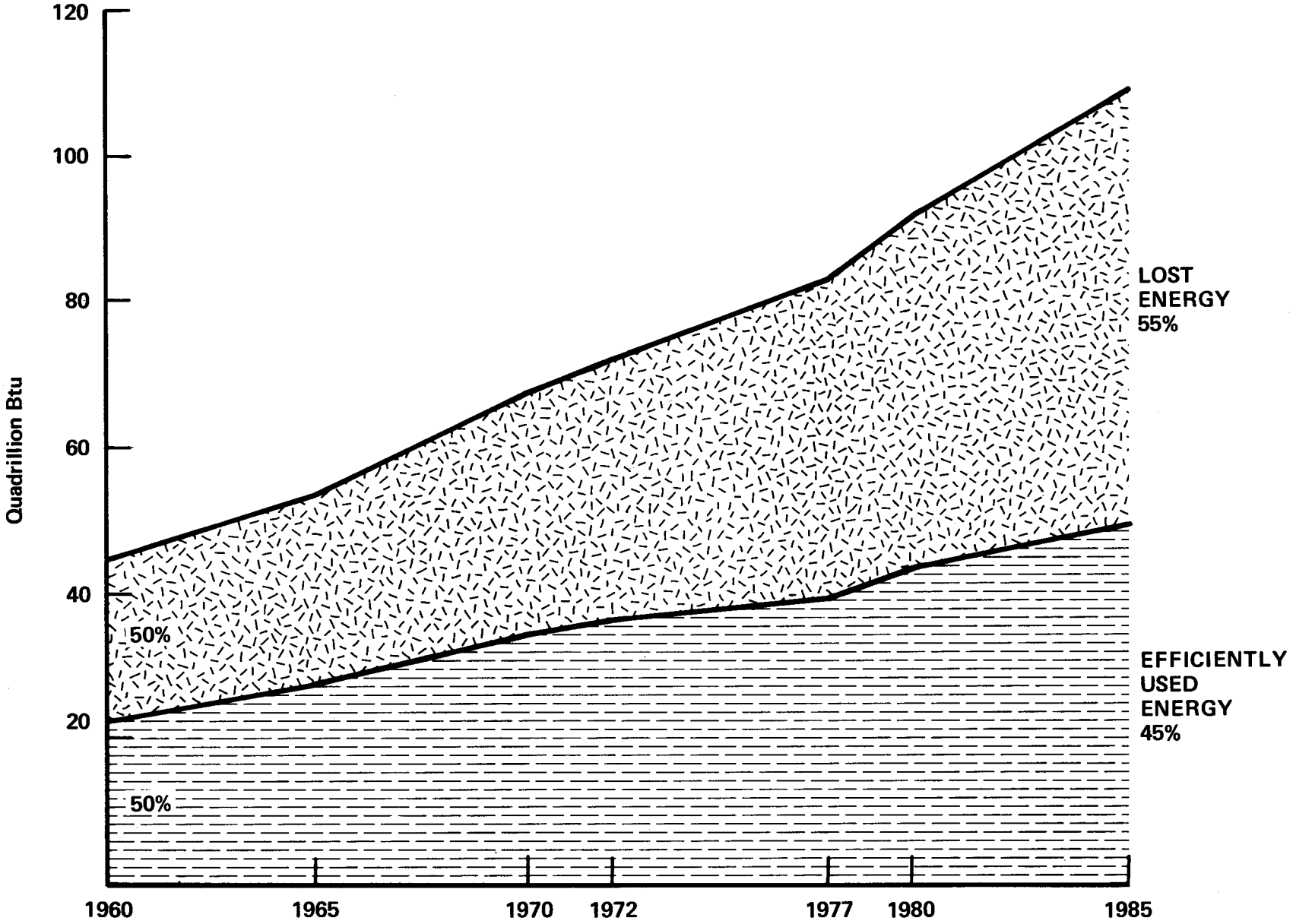
| YEAR | TOTAL ENERGY | EFFICIENTLY USED ENERGY | LOST ENERGY |
|---|---|---|---|
| 1960 | 44.4 | 22.7 | 22.3 |
| 1965 | 53.5 | 27.3 | 26.2 |
| 1970 | 67.5 | 34.2 | 33.3 |
| 1972 | 72.1 | 36.0 | 36.1 |
| 1977 | 82.6 | 39.5 | 43.1 |
| 1980 | 91.5 | 43.2 | 48.3 |
| 1985 | 109.0 | 49.4 | 59.6 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

[1] Lost energy refers to the total losses in all energy-using devices, including heating, cooling, transportation, and electricity production.

# Efficiency of Energy Utilization, 1960-85

**(Business as Usual, $7 Oil)**




Source: U.S. Department of the Interior, 1974.

# U.S. Energy Production and Gross Consumption, 1973 and 1974

Total gross energy consumption declined by 2 percent in 1974, the first such decline since 1954. The decline was due to a decrease in coal and petroleum consumption of 3 percent, and in natural gas consumption of 2 percent.

From 1973 to 1974, total energy production also declined by 2 percent. Petroleum production and natural gas (dry) production each declined by 3 percent during this period.

## U.S. Energy Production and Gross Consumption, 1973 and 1974

(Quadrillion Btu)[1]

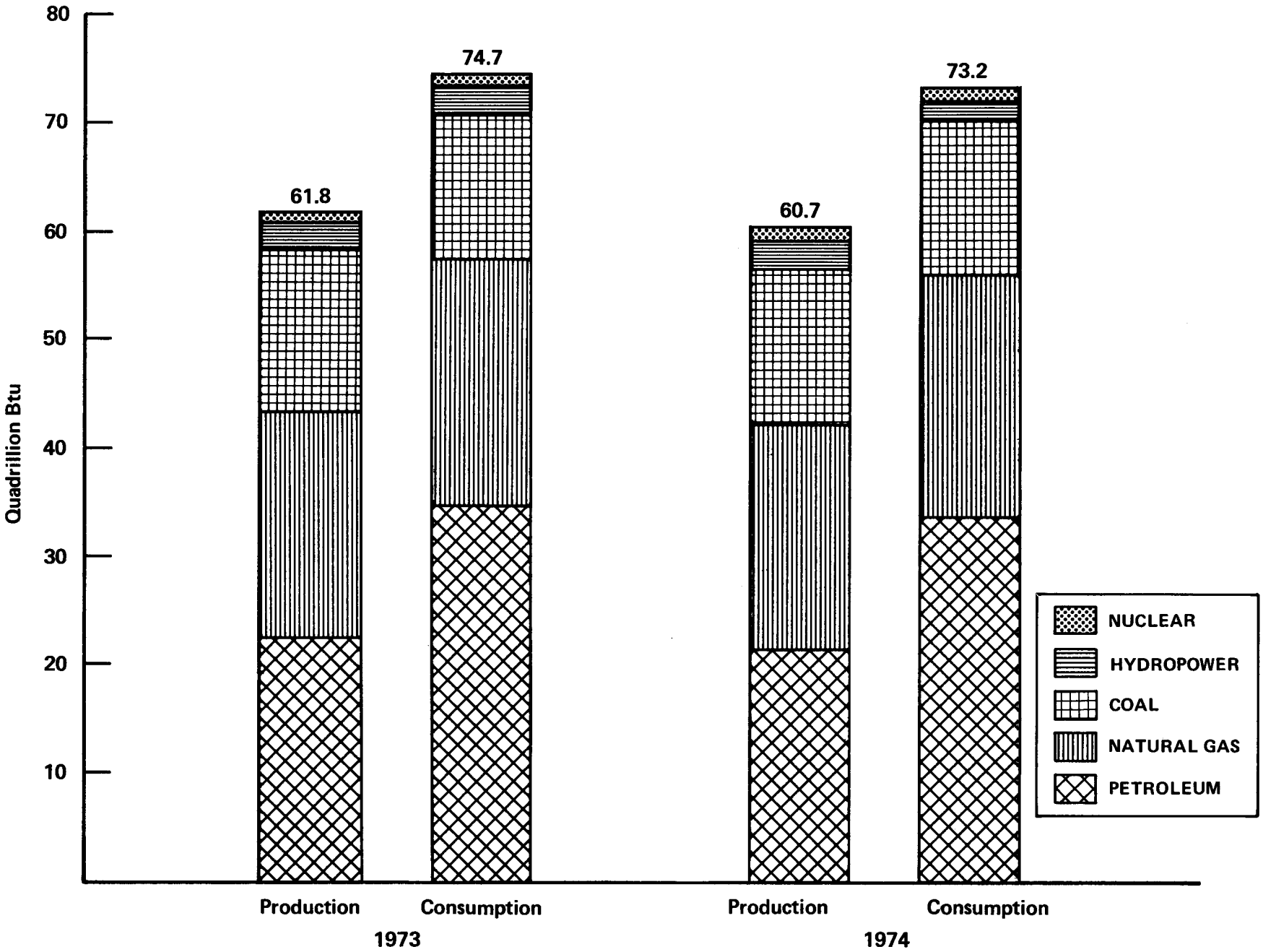
| SOURCE | 1973 | | 1974 | |
|---|---|---|---|---|
| | PRODUCTION | CONSUMPTION | PRODUCTION | CONSUMPTION |
| COAL | 14.4 | 13.4 | 14.4 | 13.0 |
| PETROLEUM[2] | 21.4 | 34.7 | 20.7 | 33.8 |
| NATURAL GAS[3] | 22.3 | 22.8 | 21.6 | 22.3 |
| HYDROPOWER | 2.8 | 2.9 | 2.8 | 2.9 |
| NUCLEAR POWER | .9 | .9 | 1.2 | 1.2 |
| TOTAL | 61.8 | 74.7 | 60.7 | 73.2 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

[2] Includes natural gas liquids.

[3] Excludes natural gas liquids.

# U.S. Energy Production and Gross Consumption, 1973 and 1974




Source: U.S. Bureau of Mines, 1975.

# U.S. Energy Trade

Between 1973 and 1974, U.S. coal exports increased 14 percent, petroleum imports remained relatively constant, and natural gas imports declined 9 percent.

In 1974, U.S. imports of petroleum and natural gas constituted 14,096 trillion Btu of energy, while exports of coal totaled 1,669 trillion Btu.

In 1974, net petroleum imports into the United States were 37 percent of U.S. gross petroleum consumption.

In 1974, net coal exports constituted 10 percent of U.S. coal production.

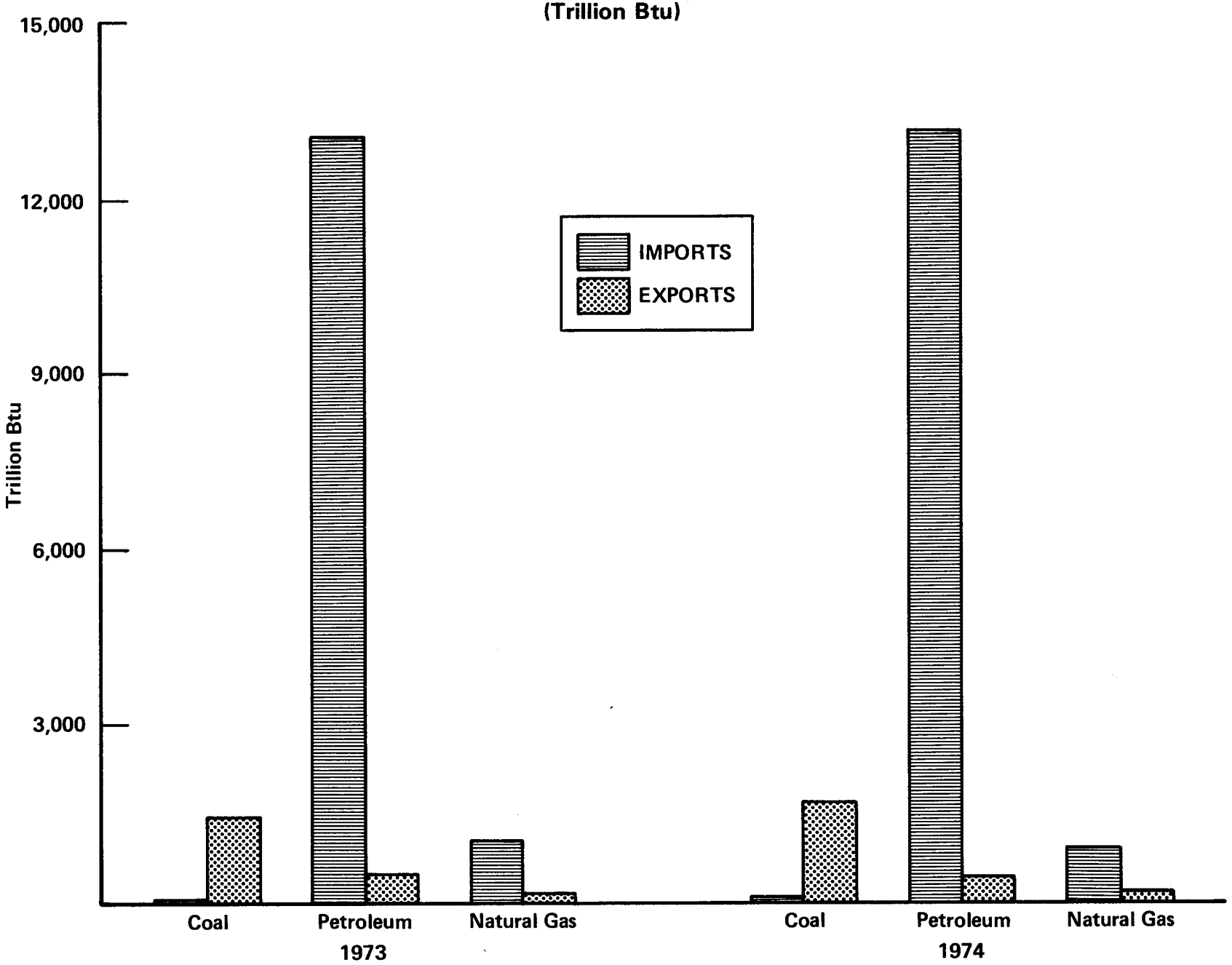
**U.S. Energy Trade**
**(Trillion Btu)[1]**

| SOURCE | 1973 | 1974 |
|---|---|---|
| COAL: | | |
| IMPORTS | 3 | 24 |
| EXPORTS | 1,460 | 1,669 |
| NET TRADE | 1,457 | 1,645 |
| PETROLEUM: | | |
| IMPORTS | 13,078 | 13,130 |
| EXPORTS | 484 | 462 |
| NET TRADE | 12,594 | 12,668 |
| NATURAL GAS: | | |
| IMPORTS | 1,061 | 966 |
| EXPORTS | 79 | 82 |
| NET TRADE | 982 | 884 |

[1] 1 Quadrillion Btu = 1,000 trillion
= 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# U.S. Energy Trade

(Trillion Btu)




Source: U.S. Bureau of Mines, 1975.

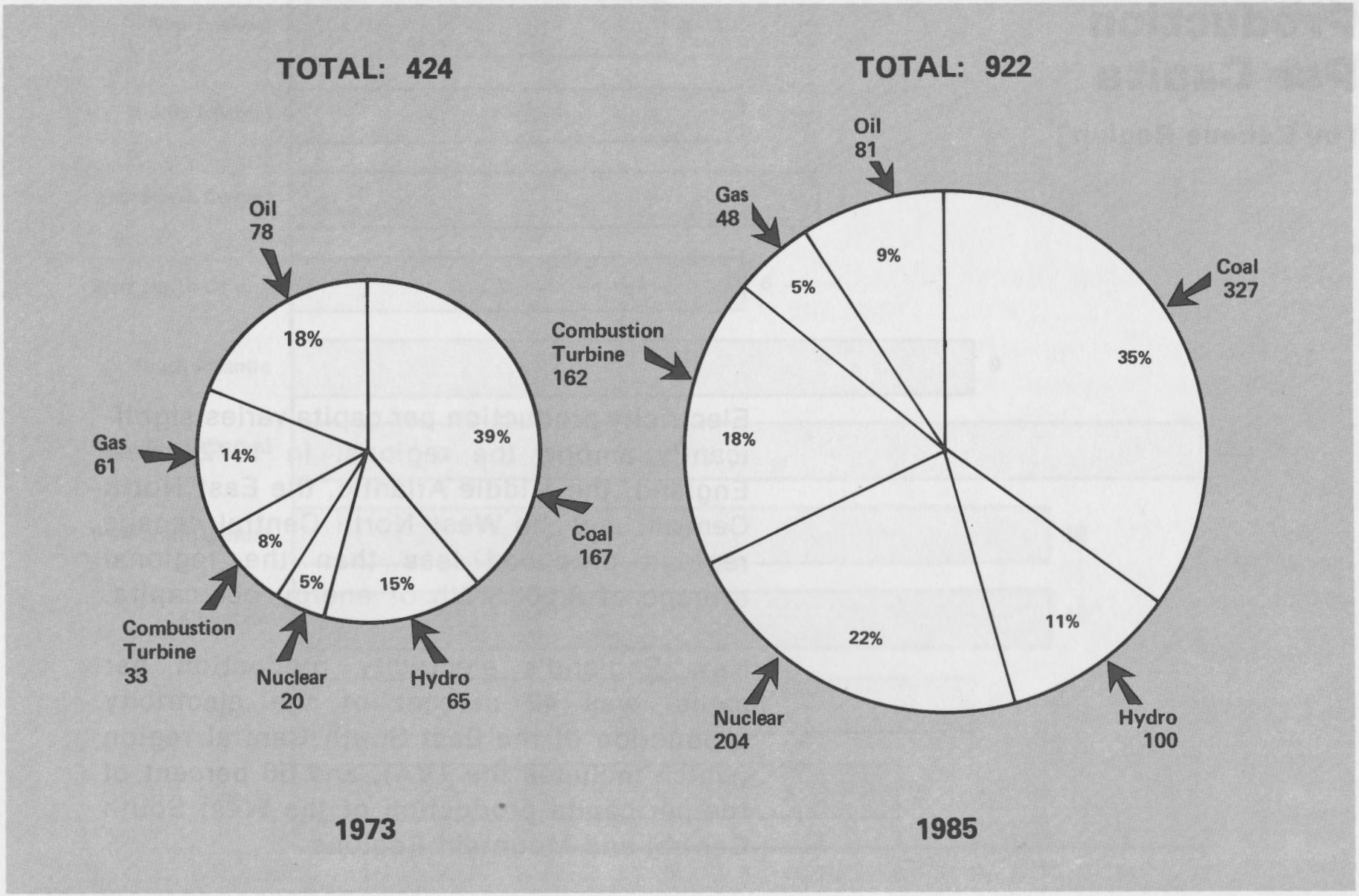
# U.S. Electric Utility Industry Capacity

Between 1973 and 1985, the capacity of the U.S. electric utility industry, assuming business as usual, $11-oil, is projected to increase 6.7 percent annually.

A significant shift in the mix of generating capacity is expected, with nuclear capacity increasing from 5 to 22 percent of the total, combustion turbine from 8 to 18 percent, oil-fired steam declining from 18 to 9 percent, and gas-fired steam declining from 14 to 5 percent of total capacity during the 1973-85 period.

# Capacity of the U.S. Electric Utility Industry, 1973 and 1985

(Thousands of Megawatts at Year End)[1]




[1] 1 megawatt = 1,000 kilowatts.

Source: Project Independence Report, 1974, page 127.

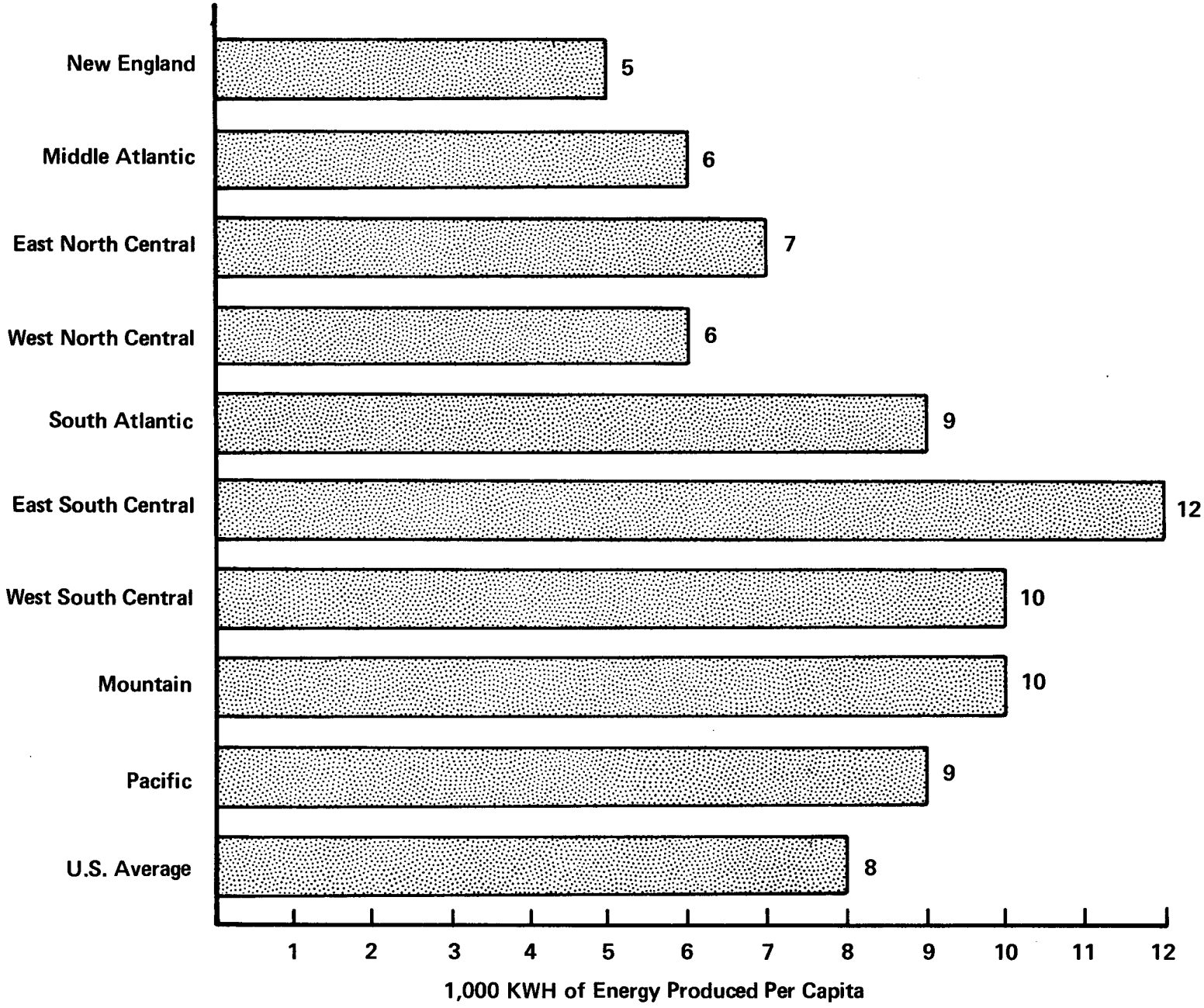
# U.S. Electricity Production Per Capita

**[by Census Region]**

Electricity production per capita varies significantly among the regions. In 1972, New England, the Middle Atlantic, the East North Central, and the West North Central census regions produced less than the regional average of 8,000 kWh of energy per capita.

New England's electricity production per capita was 42 percent of the electricity production of the East South Central region (which includes the TVA), and 50 percent of the per capita production of the West South Central and Mountain Regions.

# U.S. Electricity Production Per Capita, by Census Region , 1972




Source: Fuel and Energy Data, United States by States and Regions, 1972, U.S. Bureau of Mines Information Circular 8647, 1974.

# Energy Inputs in the Electrical Sector

**[Business as Usual, $7 Oil]**

Given business as usual, $7 oil, without conservation, energy inputs into the U.S. electrical sector are projected to increase 6 percent annually from 1973 to 1990. With conservation, inputs are projected to increase at a 5.1-percent annual rate.

Coal is the primary energy source affected by conservation, with a reduction in coal inputs of 37 percent by 1990, compared to a total energy input decline of 14 percent.

In 1985, energy inputs in the electrical sector will constitute 38 percent of gross energy consumption under business as usual, $7 oil, without conservation.

**Energy Inputs in the Electrical Sector, 1973-90**

**(Quadrillion Btu)[1]**

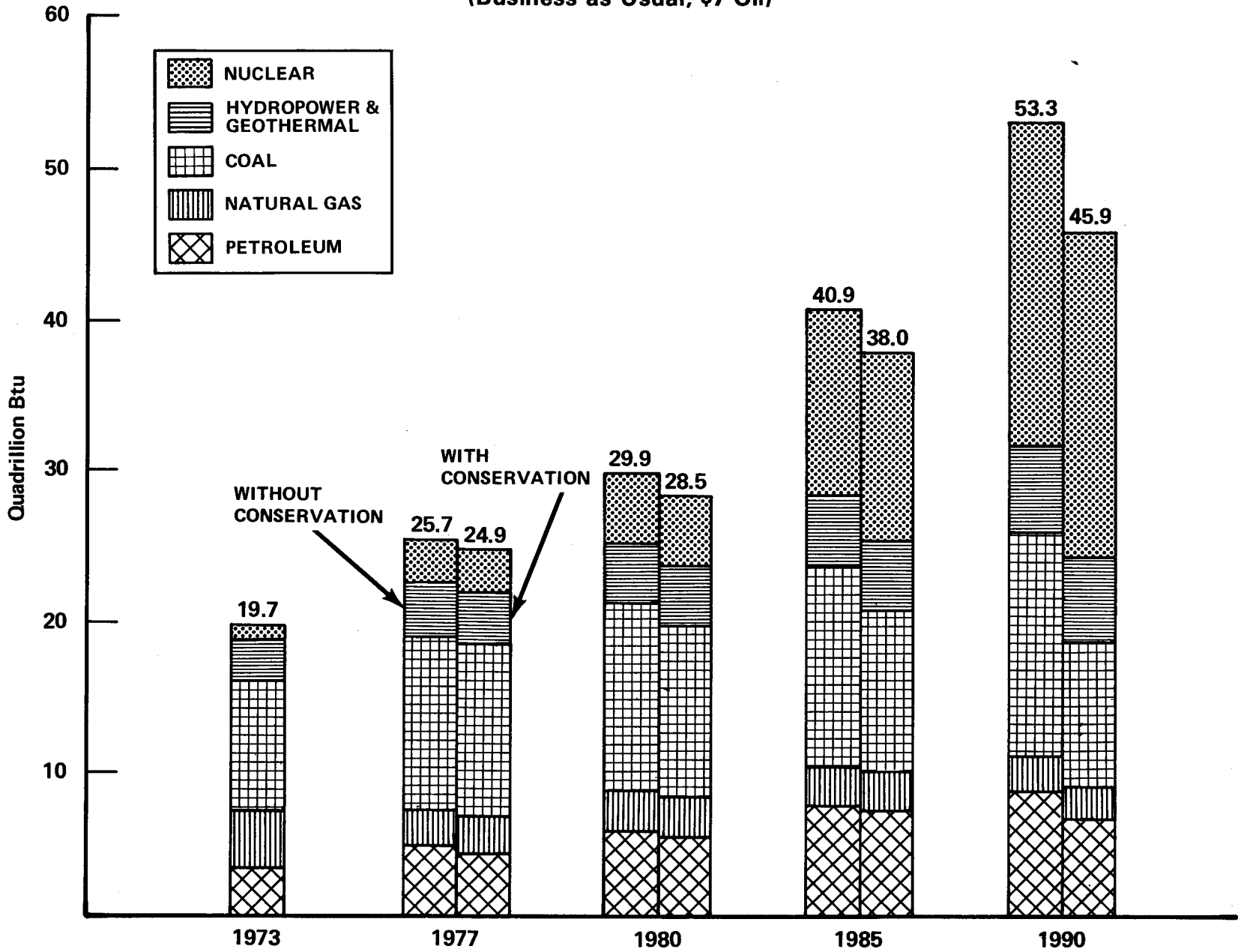
| SOURCE | 1973 | 1977 | | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 3.5 | 4.9 | 4.2 | 5.9 | 5.4 | 7.4 | 7.3 | 8.5 | 6.7 |
| NATURAL GAS | 3.7 | 2.7 | 2.7 | 2.9 | 2.9 | 2.7 | 2.7 | 2.4 | 2.4 |
| COAL | 8.7 | 11.8 | 11.7 | 12.3 | 11.4 | 13.5 | 10.7 | 15.3 | 9.7 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 3.5 | 3.5 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 2.8 | 2.8 | 4.8 | 4.8 | 12.5 | 12.5 | 21.5 | 21.5 |
| TOTAL | 19.7 | 25.7 | 24.9 | 29.9 | 28.5 | 40.9 | 38.0 | 53.3 | 45.9 |

WOC = without conservation; WC = with conservation.

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

# U.S. Energy Inputs in the Electrical Sector, 1973-90

**(Business as Usual, $7 Oil)**




Source: Project Independence Report, 1974, 1985-90 extrapolated.

# Energy Inputs in the Electrical Sector

**[Business as Usual, $11 Oil]**

Given business as usual, $11 oil, U.S. energy inputs to the electrical sector are projected to increase 5.9 percent annually from 1973 to 1990 without conservation, and at an annual rate of 4.8 percent with conservation.

Implementation of conservation is projected to reduce 1990 energy inputs to the electrical sector by 17 percent, but will not alter the contribution of nuclear power.

With conservation, inputs of energy derived from coal will be reduced in 1990 by 40 percent below inputs without conservation.

**Energy Inputs in the Electrical Sector, 1973-90**

**(Quadrillion Btu)[1]**

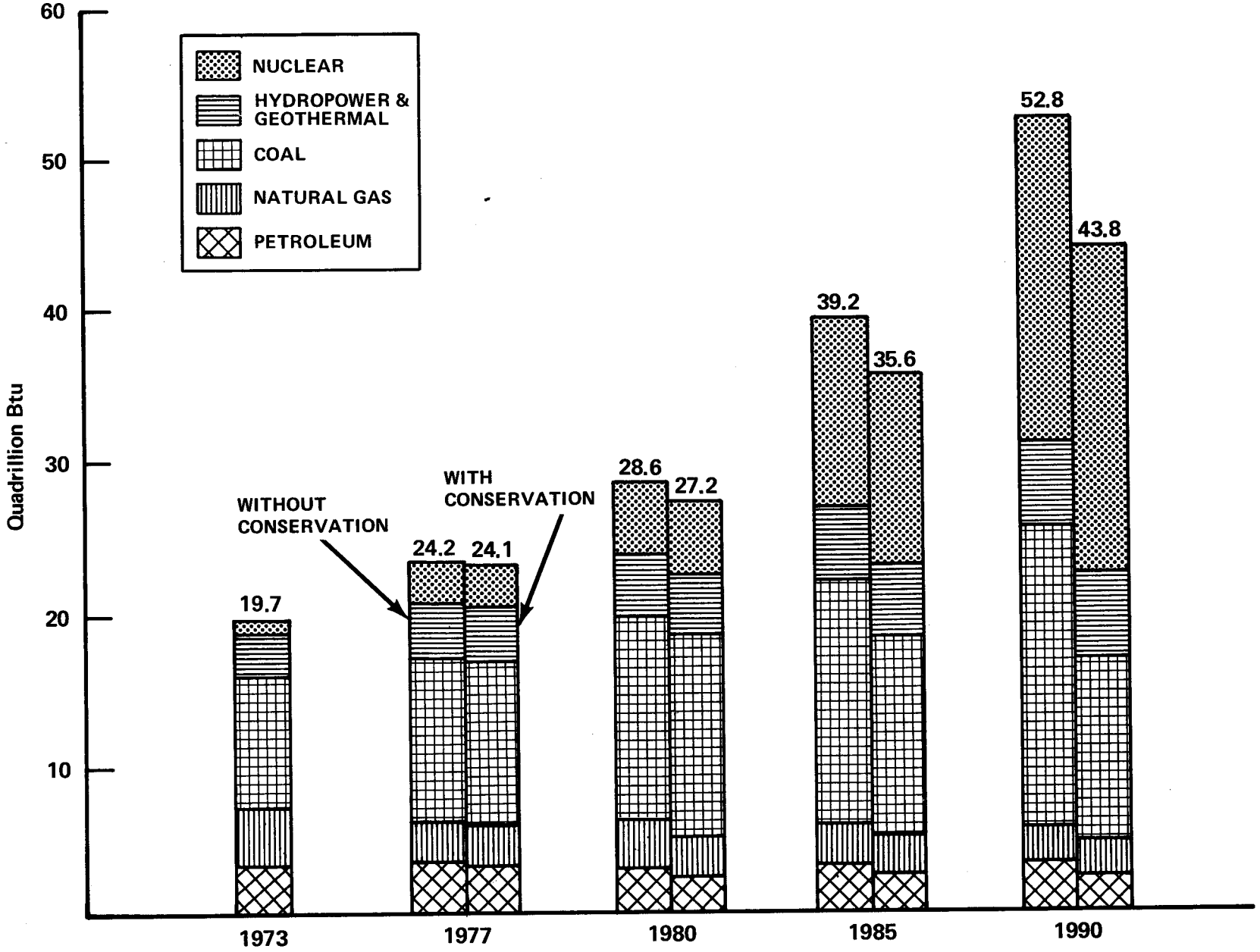
| SOURCE | 1973 | 1977 | | 1980 | | 1985 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|
| | | WOC | WC | WOC | WC | WOC | WC | WOC | WC |
| PETROLEUM | 3.5 | 3.4 | 3.3 | 3.2 | 2.6 | 3.0 | 2.4 | 3.1 | 2.1 |
| GAS | 3.7 | 2.9 | 3.0 | 3.0 | 2.8 | 2.5 | 2.5 | 2.4 | 2.4 |
| COAL | 8.7 | 11.6 | 11.5 | 13.6 | 13.0 | 16.4 | 13.4 | 20.2 | 12.2 |
| HYDROPOWER & GEOTHERMAL | 2.9 | 3.5 | 3.5 | 4.0 | 4.0 | 4.8 | 4.8 | 5.6 | 5.6 |
| NUCLEAR | .9 | 2.8 | 2.8 | 4.8 | 4.8 | 12.5 | 12.5 | 21.5 | 21.5 |
| TOTAL | 19.7 | 24.2 | 24.1 | 28.6 | 27.2 | 39.2 | 35.6 | 52.8 | 43.8 |

[1] 1 Quadrillion Btu = 500,000 barrels petroleum per day for a year
= 40 million tons of bituminous coal
= 1 trillion cubic feet of natural gas
= 100 billion kWh (based on a 10,000-Btu/kWh heat rate)

WOC = without conservation; WC = with conservation.

# U.S. Energy Inputs in the Electrical Sector, 1973-90

(Business as Usual, $11 Oil)




Source: Project Independence Report, 1974; 1985-90 extrapolated.

# Comparative Costs of Power-Generating Plants

At a 40-percent capacity factor, coal-fired generating plants operate at lower average total costs than do nuclear, oil-fired, or gas-turbine-powered plants.

At a 55-percent capacity factor, or greater, nuclear power becomes the lowest cost alternative.

Because of relatively low capital costs and short lead times, gas turbines are the most desirable source of peak power.

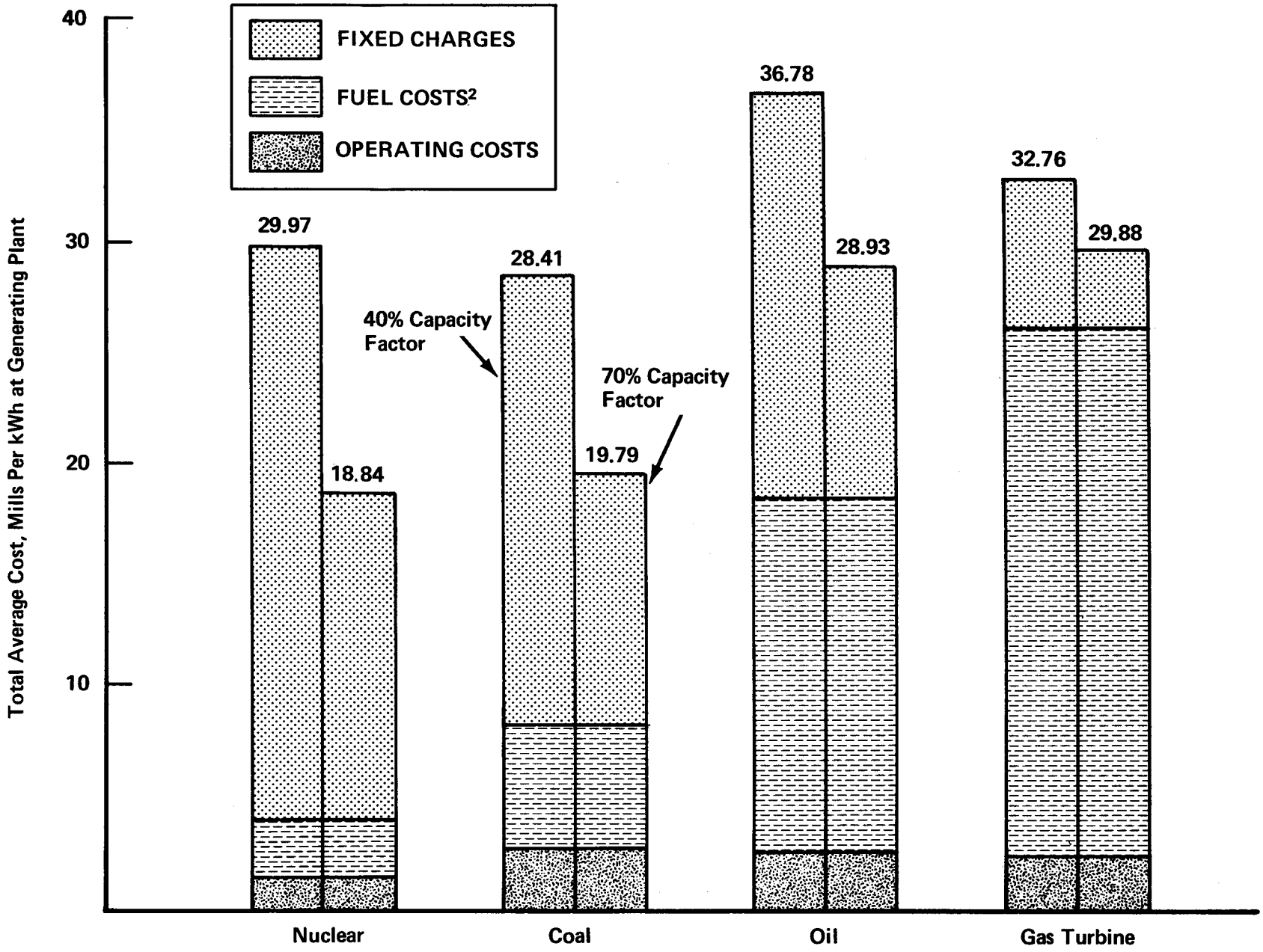
**Cost Comparisons of Alternative Power-Generating Plants, 1973 Dollars**
**(Mills Per kWh at Generating Plant)**

| ITEM | TYPE OF POWER-GENERATING PLANT | | | |
|---|---|---|---|---|
| | NUCLEAR | COAL | OIL | GAS TURBINE |
| FUEL COST | 2.50 | 5.56 | 15.83 | 23.54 |
| OPERATING AND MAINTENANCE EXPENSES[1] | 1.50 | 2.75 | 2.65 | 2.50 |
| FIXED CHARGES | | | | |
| CAPACITY FACTOR = (.7) | 14.84 | 11.48 | 10.45 | 5.12 |
| CAPACITY FACTOR = (.4) | 25.97 | 20.10 | 18.30 | 8.96 |
| TOTAL COSTS | | | | |
| CAPACITY FACTOR = (.7) | 18.84 | 19.79 | 28.93 | 29.88 |
| CAPACITY FACTOR = (.4) | 29.97 | 28.41 | 36.78 | 32.76 |

[1] Includes environmental costs.

Note.—Capacity factor refers to the proportion of total energy capacity that is used during a period of time (usually a year).

# Comparative Costs of Power-Generating Plants[1]




[1] Costs are expressed in 1973 dollars.

[2] Fuel costs are $14.52 a ton for coal, $10.59 per barrel for residual oil, and $11.77 for distillate.

Source: Project Independence Report, 1974, page 286.

# U.S. Net Electricity Consumption

**[by Sector]**

Given business as usual, $11 oil, net electricity consumption in the United States is projected to increase at an annual rate of 5.7 percent during the 1973-85 period.

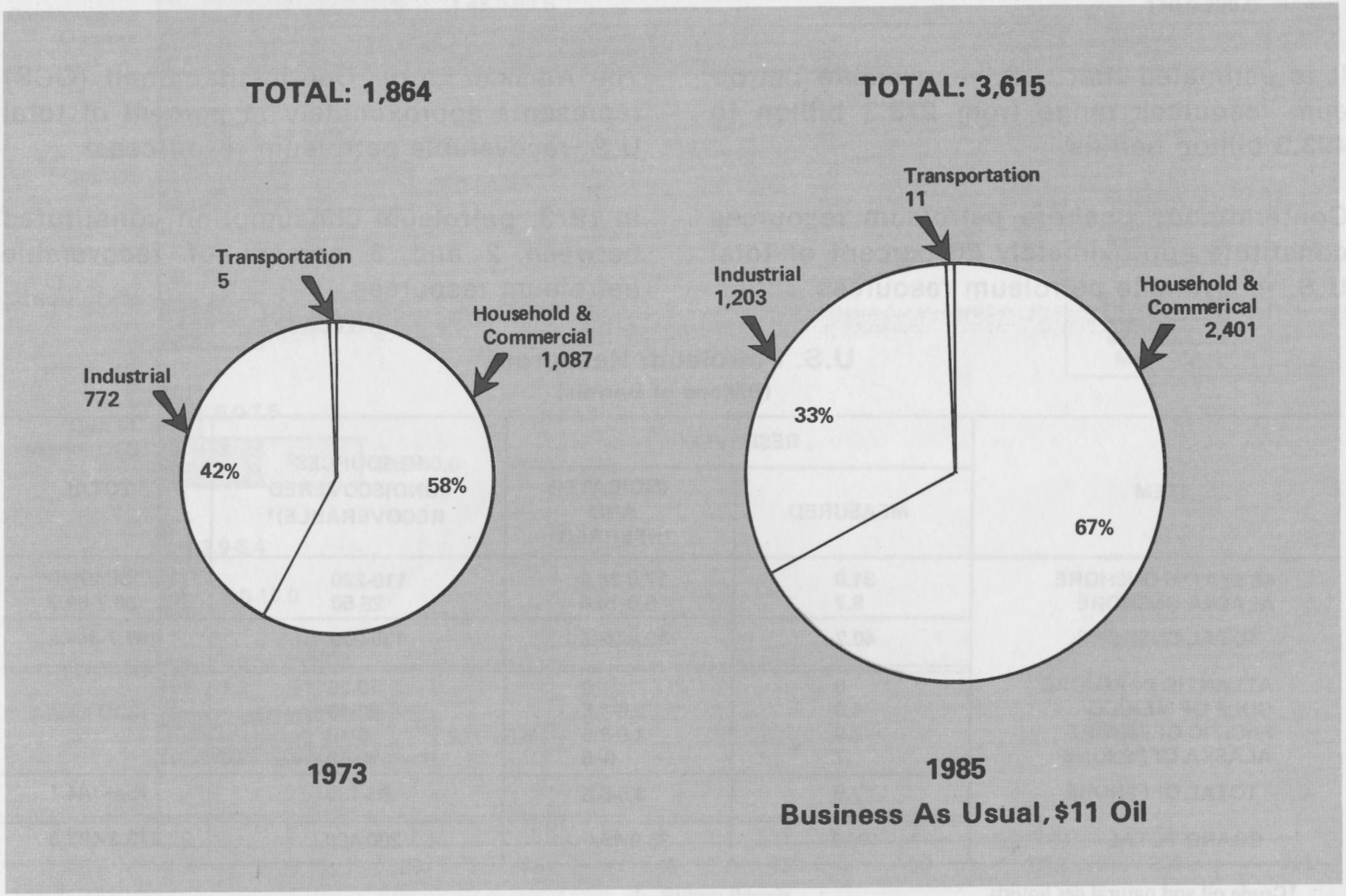
Household and commercial consumption of electricity is estimated to increase at an annual rate of 6.8 percent and industrial consumption at an annual rate of 3.8 percent.

U.S. net electricity consumption in 1973 was 10.4 percent of total net energy consumption in the United States.[1]

[1] Electrical energy used by the final consuming sectors was converted on the basis of 3,412 Btu per kilowatt hour.

# U.S. Net Electricity Consumption by Sector, 1973 and 1985[1]

**(In Billions of Kilowatt Hours)**




[1] Net generation plus net imports (includes transmission losses).

Source: U.S. Bureau of Mines, 1974;
Project Independence Report, 1974.

# U.S. Recoverable Petroleum Resources

It is estimated that U.S. recoverable petroleum resources range from 273.3 billion to 493.3 billion barrels.

Conterminous onshore petroleum resources constitute approximately 56 percent of total U.S. recoverable petroleum resources.

The Alaskan Outer Continental Shelf (OCS) represents approximately 11 percent of total U.S. recoverable petroleum resources.

In 1973, petroleum consumption constituted between 2 and 3 percent of recoverable petroleum resources.

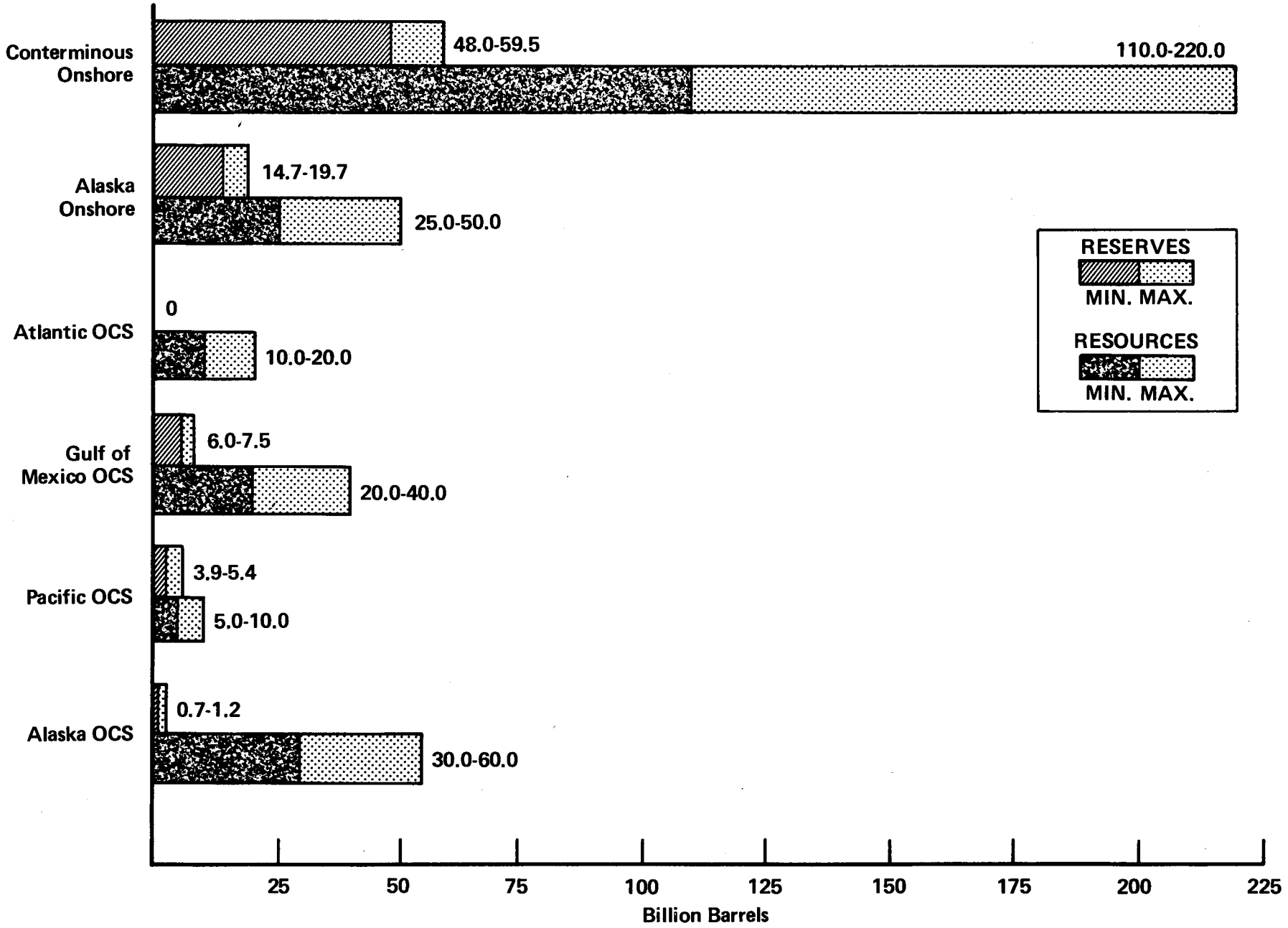
**U.S. Petroleum Resources[1]**
**(Billions of Barrels)**

| ITEM | RESERVES[2] | | RESOURCES[2] (UNDISCOVERED RECOVERABLE)[1] | TOTAL |
|---|---|---|---|---|
| | MEASURED | INDICATED AND INFERRED | | |
| 48 STATES ONSHORE | 31.0 | 17.0-28.5 | 110-220 | 158-279.5 |
| ALASKA ONSHORE | 9.7 | 5.0-10.0 | 25-50 | 39.7-69.7 |
| TOTAL ONSHORE | 40.7 | 22.0-38.5 | 135-270 | 197.7-349.2 |
| ATLANTIC OFFSHORE | 0 | 0 | 10-20 | |
| GULF OF MEXICO | 4.0 | 2.0-3.5 | 20-40 | |
| PACIFIC OFFSHORE | 2.9 | 1.0-2.5 | 5-10 | |
| ALASKA OFFSHORE | .7 | 0-.5 | 30-60 | |
| TOTAL OFFSHORE | 7.6 | 3.0-6.5 | 65-130 | 75.6-144.1 |
| GRAND TOTAL | 48.3 | 25.0-45.0 | 200-400 | 273.3-493.3 |

[1] Crude oil and natural gas liquids.

[2] See glossary for definition of terms.

# U.S. Recoverable Petroleum Resources




Source: U.S. Geological Survey, News Release, March 1974.

# U.S. Undiscovered Recoverable Petroleum[1] Resources[2]

## [Alternative Estimates]

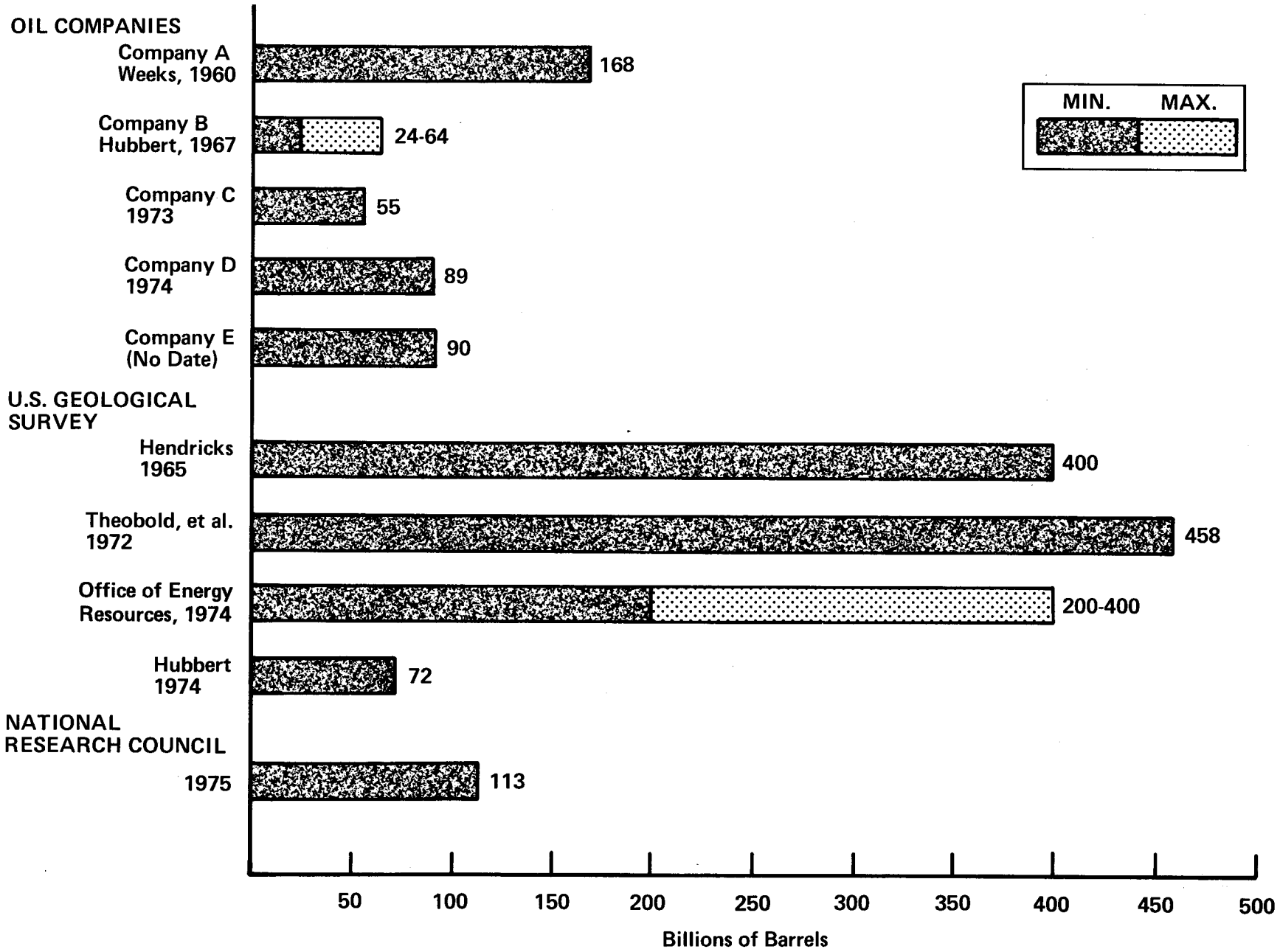
It is evident from the following chart that the estimates of undiscovered recoverable petroleum resources vary considerably, ranging from a low of 55 to a high of 458 billion barrels of petroleum.

The estimate developed by the Office of Energy Resources of the U.S. Geological Survey has been used in the text of this study.

[1] Crude oil and natural gas liquids.

[2] Undiscovered recoverable resources are quantities of an energy commodity that may be reasonably expected to exist in favorable geologic settings, but that have not yet been identified by drilling.

# Alternative Estimates of U.S. Undiscovered Recoverable Petroleum Resources




Source: National Academy of Sciences, Mineral Resources and The Environment, 1975, page 89.

# U.S. Petroleum Supply

From 1960 to 1970, domestic production of petroleum increased 3.5 percent annually. Since 1970, however, domestic petroleum production has declined at a 1.7-percent annual rate.

Net imports of crude oil and petroleum products have increased 9.8 percent annually since 1960, and at a 17.2-percent annual rate since 1970.

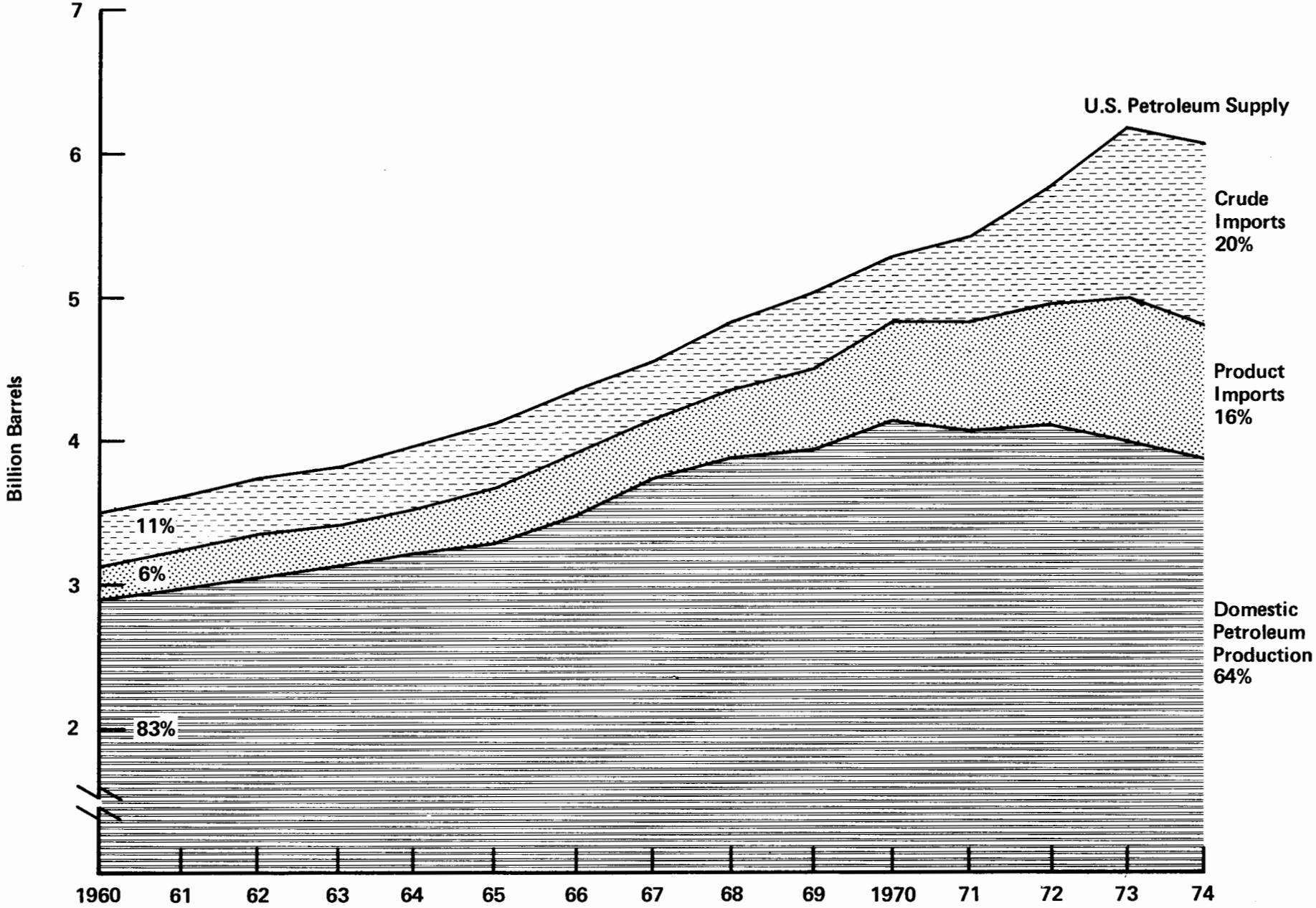
**U.S. Petroleum Supply, 1960-74**

**(Billions of Barrels)**

| YEAR | DOMESTIC PRODUCTION[1] | NET IMPORTS | | TOTAL |
|---|---|---|---|---|
| | | PRODUCTS | CRUDE OIL | |
| 1960 | 2.92 | .22 | .37 | 3.51 |
| 1965 | 3.29 | .38 | .45 | 4.12 |
| 1970 | 4.12 | .68 | .48 | 5.28 |
| 1971 | 4.07 | .74 | .61 | 5.42 |
| 1972 | 4.09 | .84 | .81 | 5.74 |
| 1973 | 4.00 | 1.00 | 1.18 | 6.18 |
| 1974 | 3.85 | .94 | 1.25 | 6.04 |

[1] Includes natural gas liquids.

# U.S. Petroleum Supply, 1960-74




Source: U.S. Bureau of Mines, 1974.

# U.S. Petroleum Production

From 1960 to 1974, cumulative production of petroleum in the United States totaled 53,792.6 million barrels.

During the 1960-70 period, U.S. petroleum production[1] increased at an annual rate of 3.5 percent. Since 1970, however, petroleum production has declined at an annual rate of .6 percent. Onshore petroleum production increased at an annual rate of 2.7 percent between 1960 and 1970, but declined at an annual rate of .9 percent since 1970.

From 1960 to 1971, petroleum production on the Outer Continental Shelf (OCS) increased at an annual rate of 21.8 percent, but declined at an annual rate of 2.3 percent since 1971.

**U.S. Petroleum Production, 1960-74**
**(Millions of Barrels)**

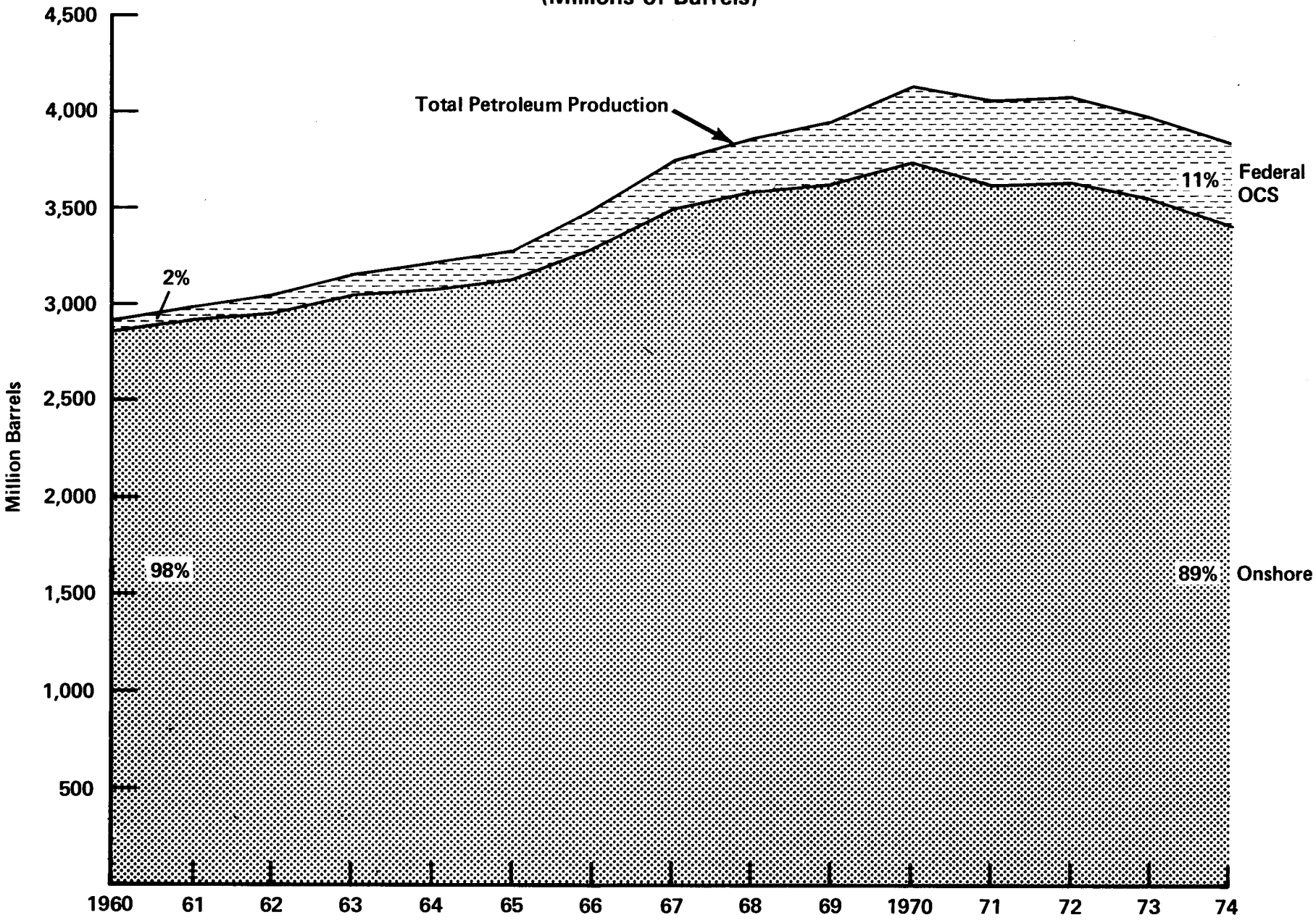
| | Onshore | Federal OCS | Production Total |
|---|---|---|---|
| 1960 | 2,862.9 | 52.2 | 2,915.1 |
| 1961 | 2,916.2 | 67.3 | 2,983.5 |
| 1962 | 2,954.7 | 94.2 | 3,048.9 |
| 1963 | 3,043.5 | 110.1 | 3,153.6 |
| 1964 | 3,080.8 | 128.5 | 3,209.3 |
| 1965 | 3,138.6 | 151.5 | 3,290.1 |
| 1966 | 3,297.7 | 198.7 | 3,496.4 |
| 1967 | 3,497.3 | 232.9 | 3,730.2 |
| 1968 | 3,595.3 | 284.0 | 3,879.3 |
| 1969 | 3,619.1 | 332.9 | 3,952.0 |
| 1970 | 3,737.1 | 386.2 | 4,123.3 |
| 1971 | 3,616.3 | 455.4 | 4,071.7 |
| 1972 | 3,640.3 | 453.3 | 4,093.6 |
| 1973 | 3,562.0 | 433.6 | 3,995.3 |
| 1974 | 3,425.8 | 424.2 | 3,850.0 |



[1] Includes crude oil production, condensate, and natural gas liquids. Approximately one-sixth of total petroleum production consists of natural gas liquids.

# U.S. Petroleum Production, 1960-74

(Millions of Barrels)




Source: U.S. Geological Survey; U.S. Bureau of Mines, 1974.

# U.S. Petroleum Consumption

**[by Product]**

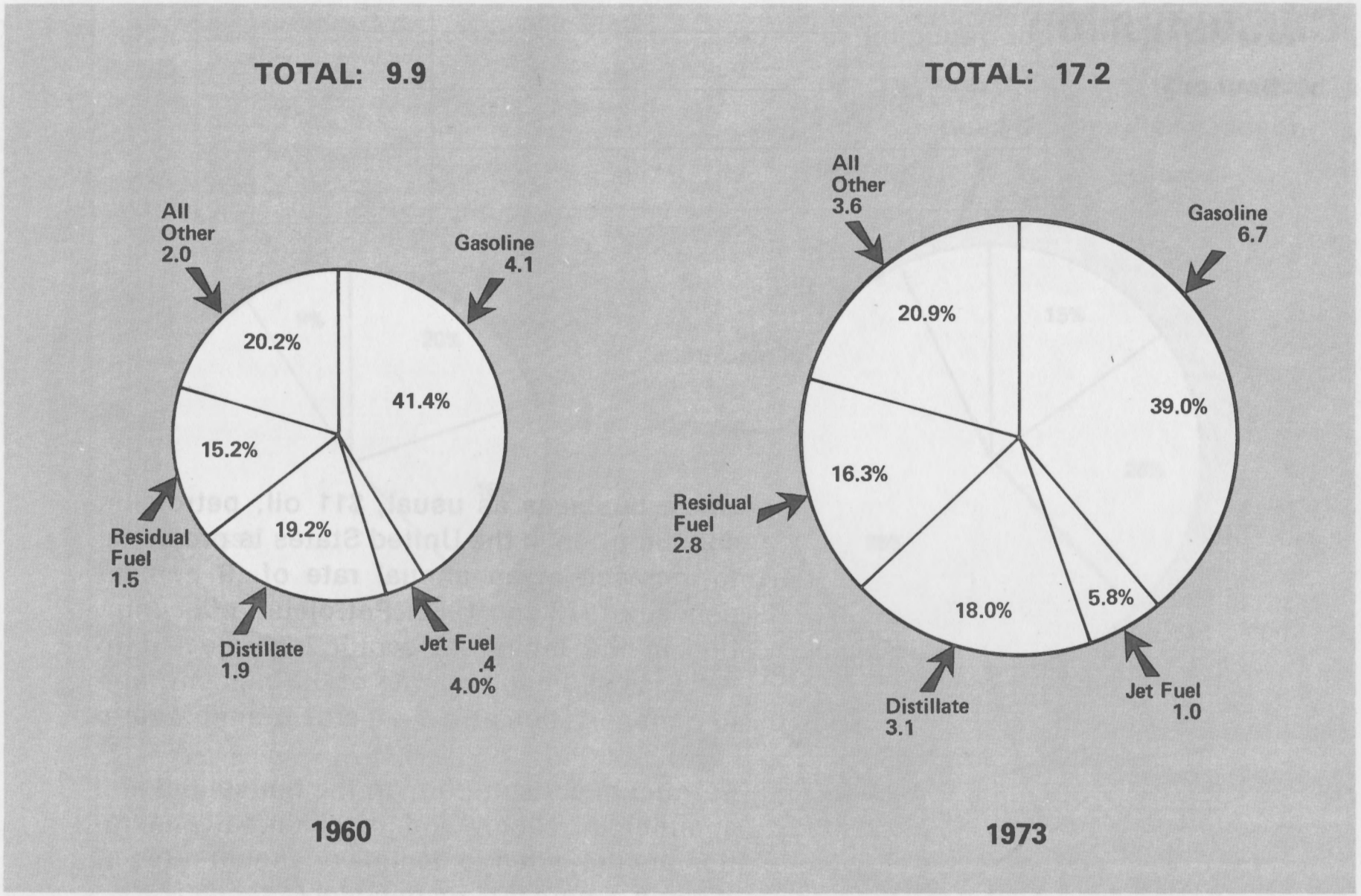
Between 1960 and 1973, consumption of petroleum products in the United States increased at an annual rate of 4.3 percent.

Consumption of gasoline has increased at an annual rate of 3.9 percent since 1960, residual fuel oil at an annual rate of 4.9 percent, and distillate at an annual rate of 3.8 percent.

The relative share of each petroleum product has not changed significantly during the 1960-73 period.

# U.S. Petroleum Consumption By Product, 1960 and 1973

(Millions of Barrels Per Day)




Source: U.S. Bureau of Mines, 1974.

# U.S. Petroleum Consumption

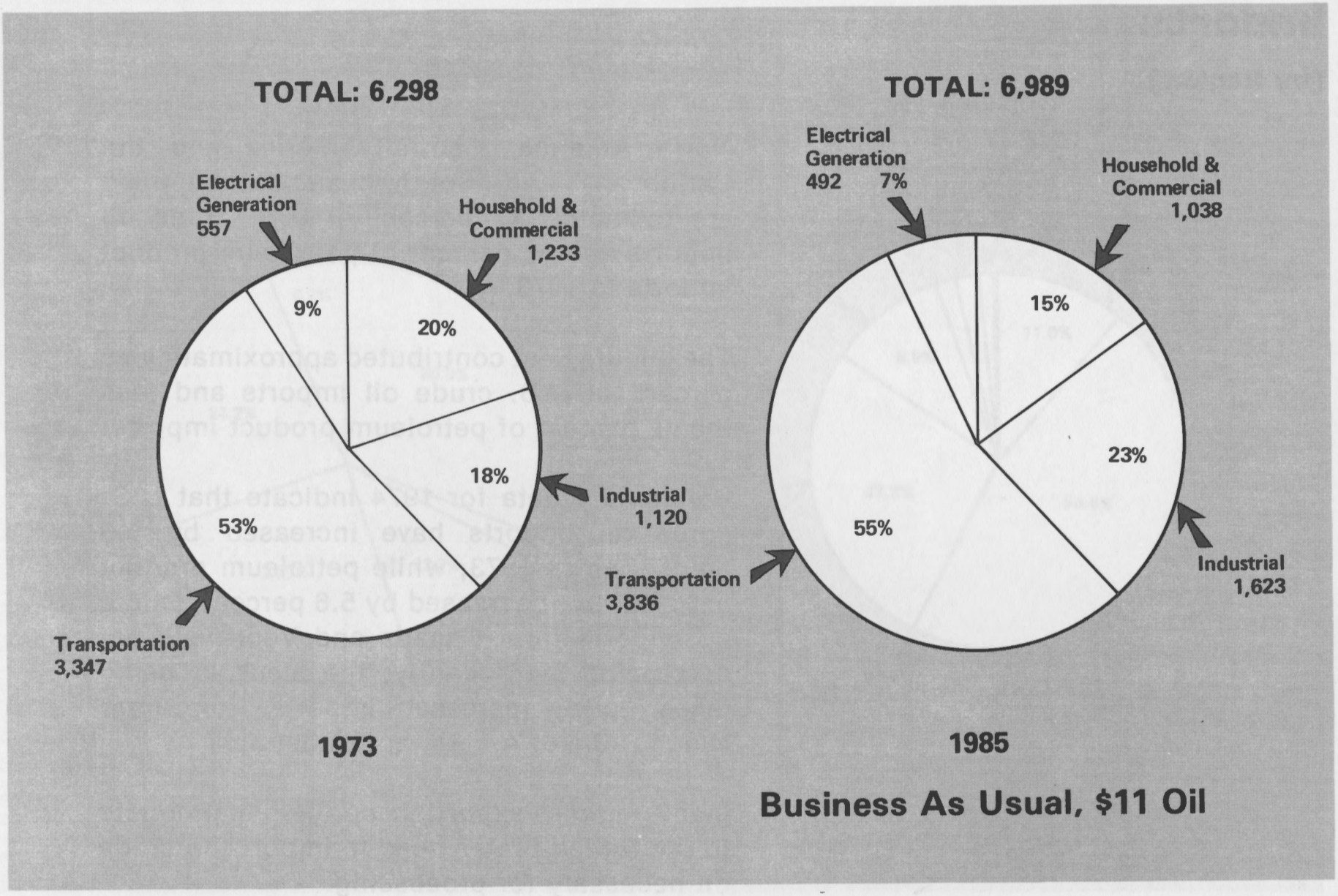
**[by Sector]**

Given business as usual, $11 oil, petroleum consumption in the United States is projected to increase at an annual rate of .9 percent between 1973 and 1985. Petroleum consumption in the industrial sector is projected to increase at an annual rate of 3.1 percent, and in transportation at a 1.1-percent annual rate.

Petroleum consumption in the household and commercial sector and in electrical generation are projected to decline at annual rates of 1.4 and 1 percent, respectively.

# U.S. Petroleum Consumption, by Sector, 1973 and 1985

(Millions of Barrels)




Source: U.S. Bureau of Mines, 1974;
Project Independence Report, 1974.

# U.S. Petroleum Imports

**(by Region)**

North America, Central America and the Caribbean, and South America supplied approximately 45 percent of U.S. crude oil imports and 57 percent of petroleum product imports in 1973.

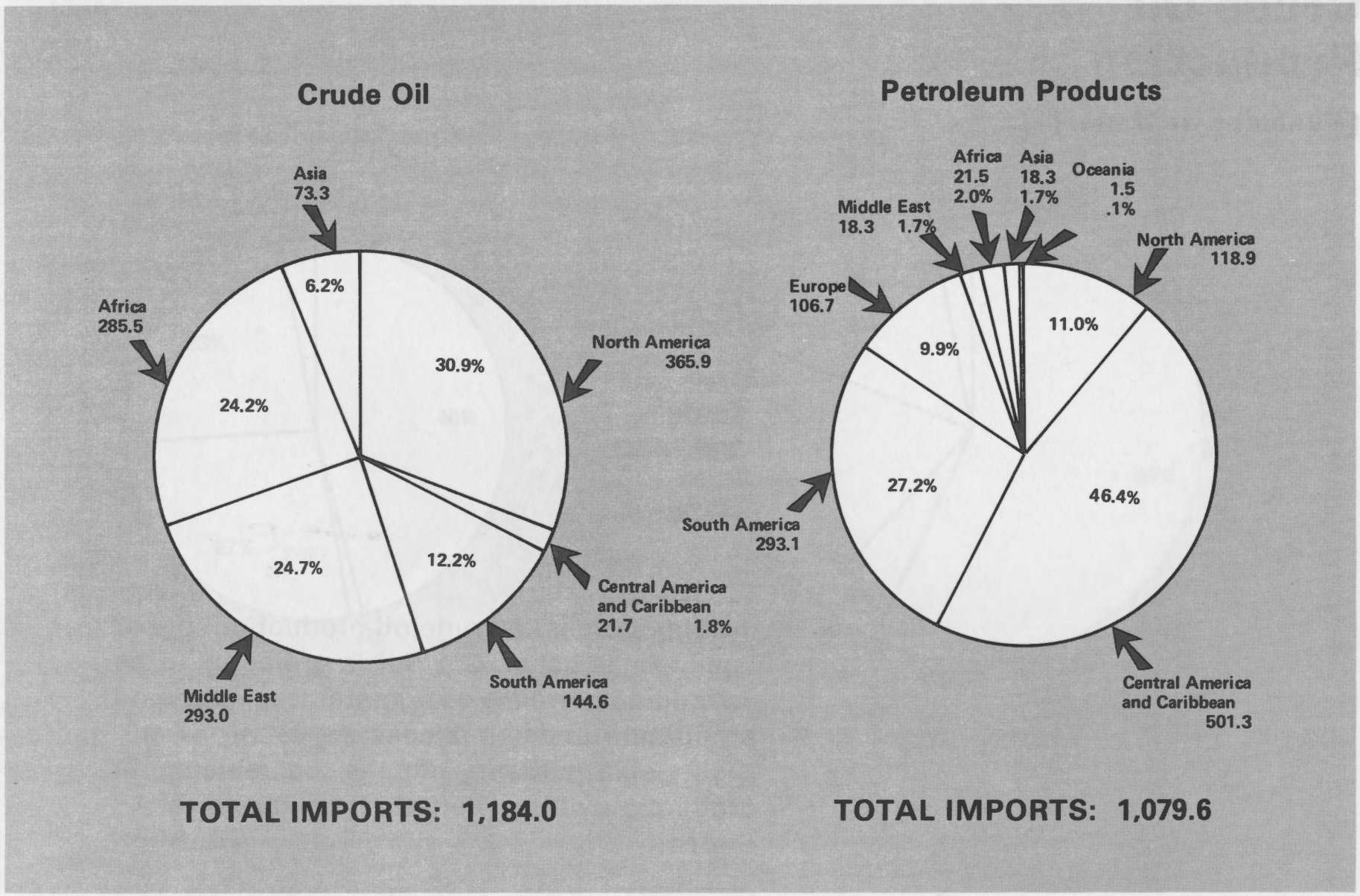
The Middle East contributed approximately 25 percent of U.S. crude oil imports and less than 2 percent of petroleum product imports.

Preliminary data for 1974 indicate that U.S. crude oil imports have increased by 5.5 percent since 1973, while petroleum product imports have decreased by 5.6 percent. Crude oil imports from Canada and Venezuela are decreasing significantly; the slack is being taken up by increased imports from Iran, Nigeria, Saudi Arabia, and Algeria.

Many regions exporting petroleum products to the United States need to import the crude oil necessary for processing.

# U.S. Petroleum Imports by Region, 1973

(Millions of Barrels)




Source: U.S. Bureau of Mines, 1974.

# Projected U.S. Crude Oil Production

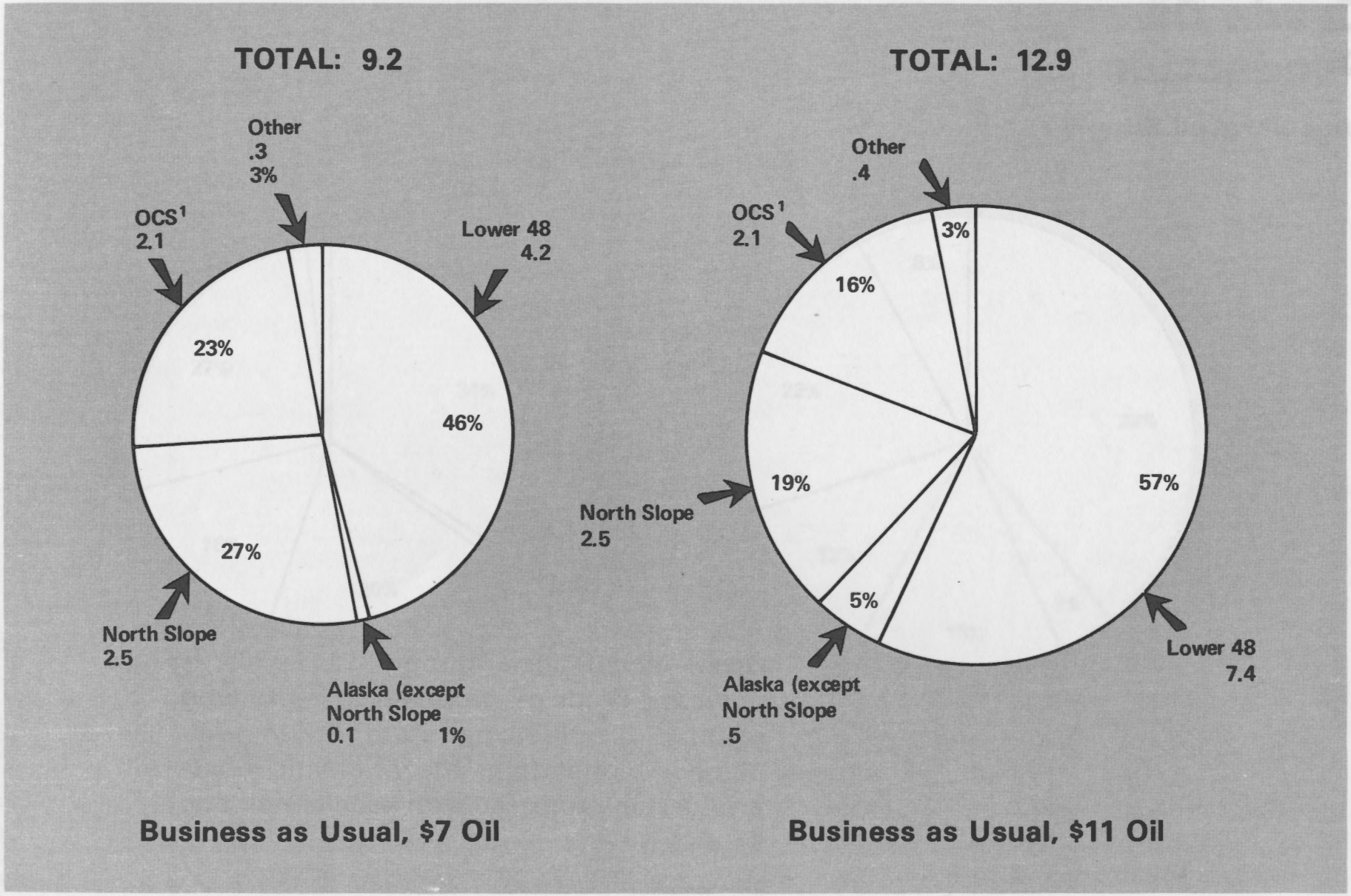
**[Business as Usual]**

In 1985, domestic crude oil production[1] under business as usual, $11 oil, is projected to be 3.7 million barrels a day greater than crude oil production under business as usual, $7 oil. Eighty-six percent of the increment in production will be derived from the lower 48 States.

[1]Does not include natural gas liquids. Given $7 oil, these liquids would total approximately 2.3 million barrels per day in 1985. For $11 oil, natural gas liquid production is projected at 2.9 million barrels per day.

# Projected U.S. Crude Oil Production, 1985

**(Millions of Barrels Per Day)**




[1]OCS = Outer Continental Shelf.

Source: Project Independence Report, 1974, page 47.

# Projected U.S. Crude Oil Production

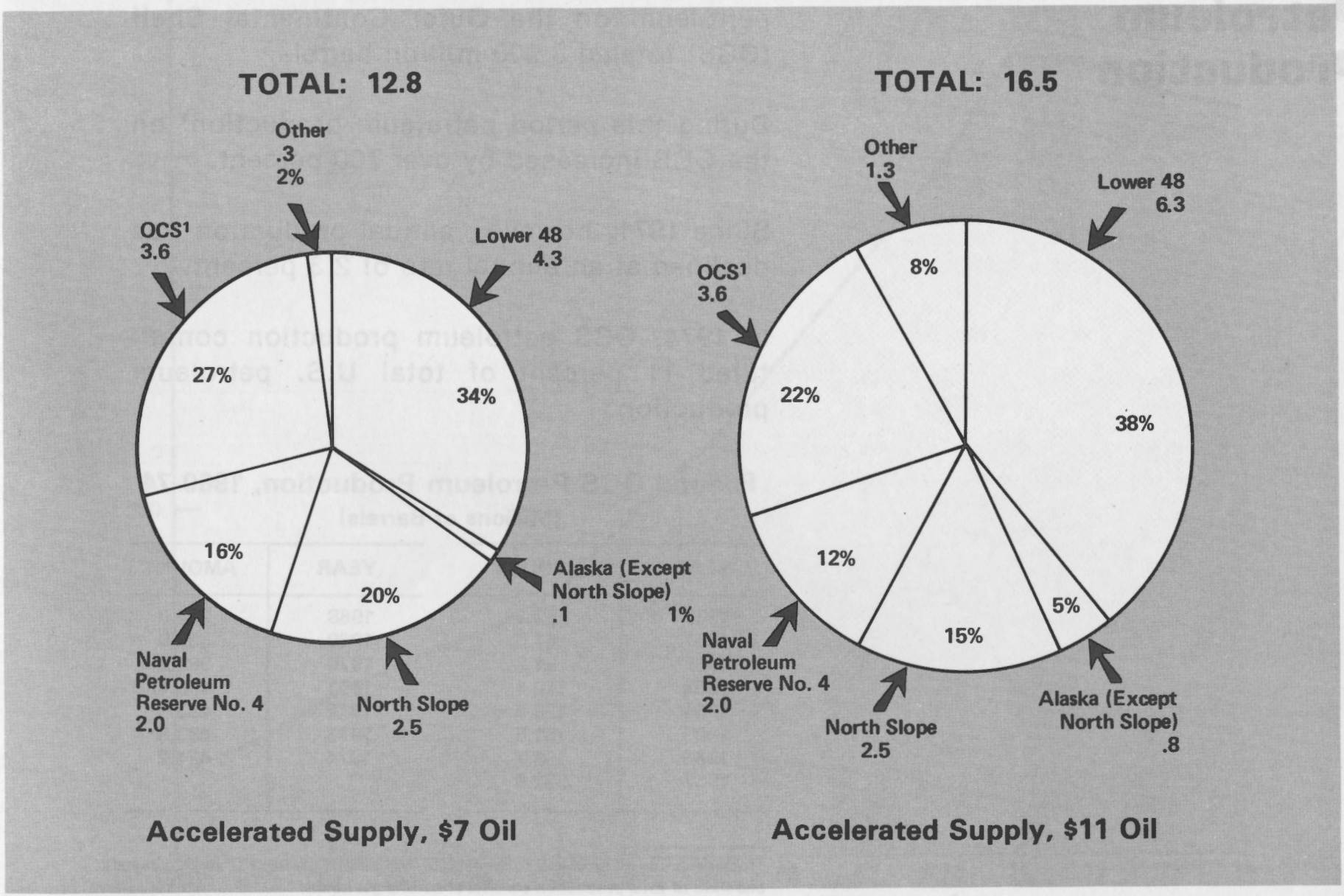
**[Accelerated Supply]**

Given accelerated supply, $11 oil, total domestic crude oil production[1] is projected to reach 16.5 million barrels a day in 1985, 29 percent higher than the domestic crude oil production projected with accelerated supply, $7 oil.

[1] Does not include natural gas liquids.

# Projected U.S. Crude Oil Production, 1985

**(Millions of Barrels Per Day)**




[1]OCS = Outer Continental Shelf.

Source: Project Independence Report, 1974, page 47.

# Federal OCS Petroleum Production

From 1960 to 1974, cumulative production of petroleum on the Outer Continental Shelf (OCS) totaled 3,900 million barrels.

During this period petroleum production[1] on the OCS increased by over 700 percent.

Since 1971, however, annual production has declined at an annual rate of 2.3 percent.

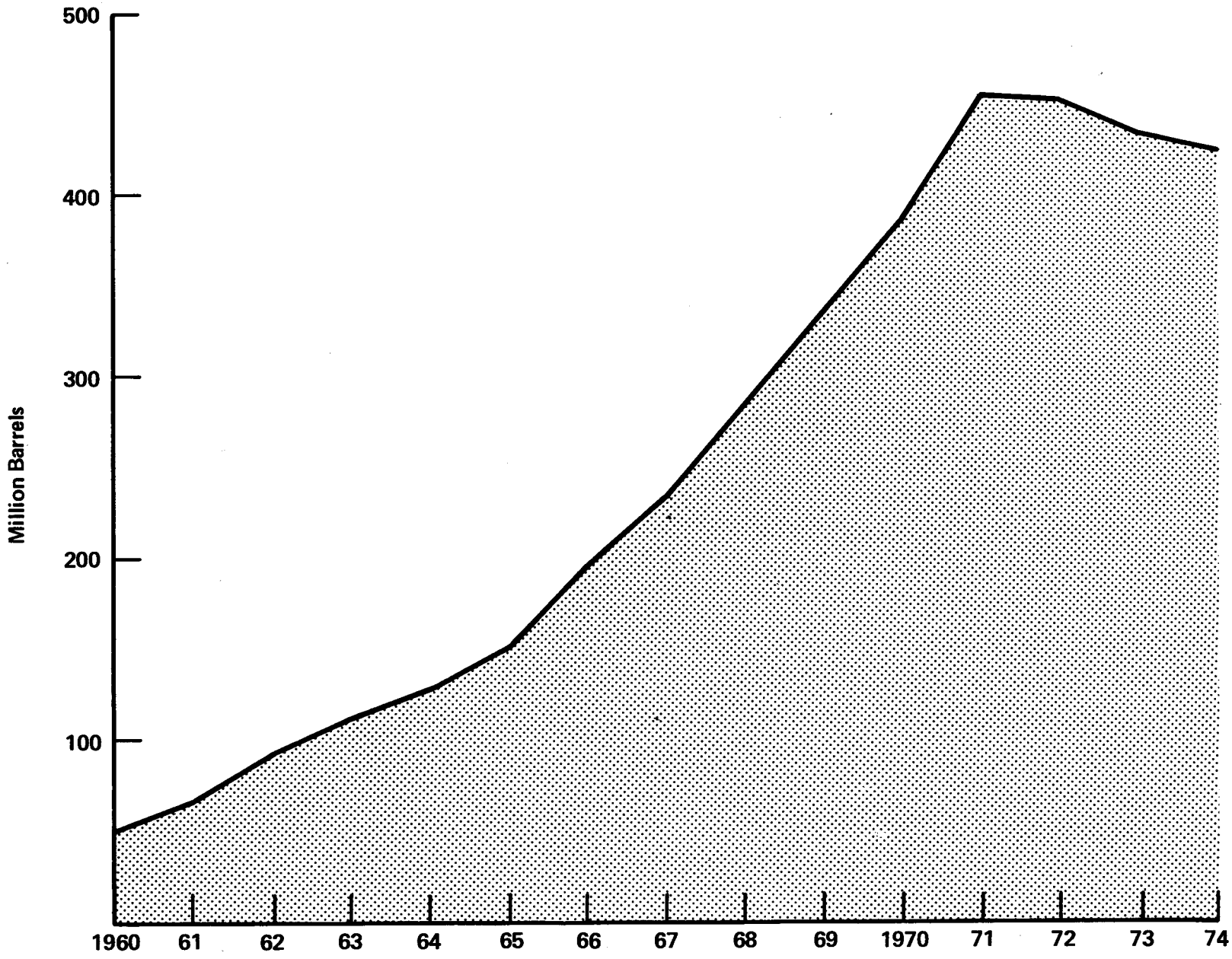
In 1974, OCS petroleum production constituted 11 percent of total U.S. petroleum production.

**Federal OCS Petroleum Production, 1960-74**
**(Millions of Barrels)**

| YEAR | AMOUNT | YEAR | AMOUNT |
|---|---|---|---|
| 1960 | 52.2 | 1968 | 284.0 |
| 1961 | 67.3 | 1969 | 332.9 |
| 1962 | 94.2 | 1970 | 386.2 |
| 1963 | 110.1 | 1971 | 455.4 |
| 1964 | 128.5 | 1972 | 453.3 |
| 1965 | 151.5 | 1973 | 433.6 |
| 1966 | 198.7 | 1974 | 424.2 |
| 1967 | 232.9 | | |

[1] Includes crude oil production, condensate, and natural gas liquids. Approximately one-sixth of total production consists of natural gas liquids.

# Federal OCS Petroleum Production, 1960-74




Source: U.S. Geological Survey, 1974.

# Federal OCS Oil and Gas Leases

From the 6.9 million Outer Continental Shelf (OCS) acres leased between 1960 and 1973, 1.4 billion barrels of petroleum and 7.3 trillion cubic feet of gas were produced by the end of 1973.

The relationship between oil and gas acreage leased and offered on the OCS has varied significantly since 1960. For example, in 1970 the ratio was 89 percent, and in 1974, 36 percent.

Between 1973 and 1974, OCS oil and gas acreage offered increased by 227 percent, while acreage leased increased by only 71 percent.

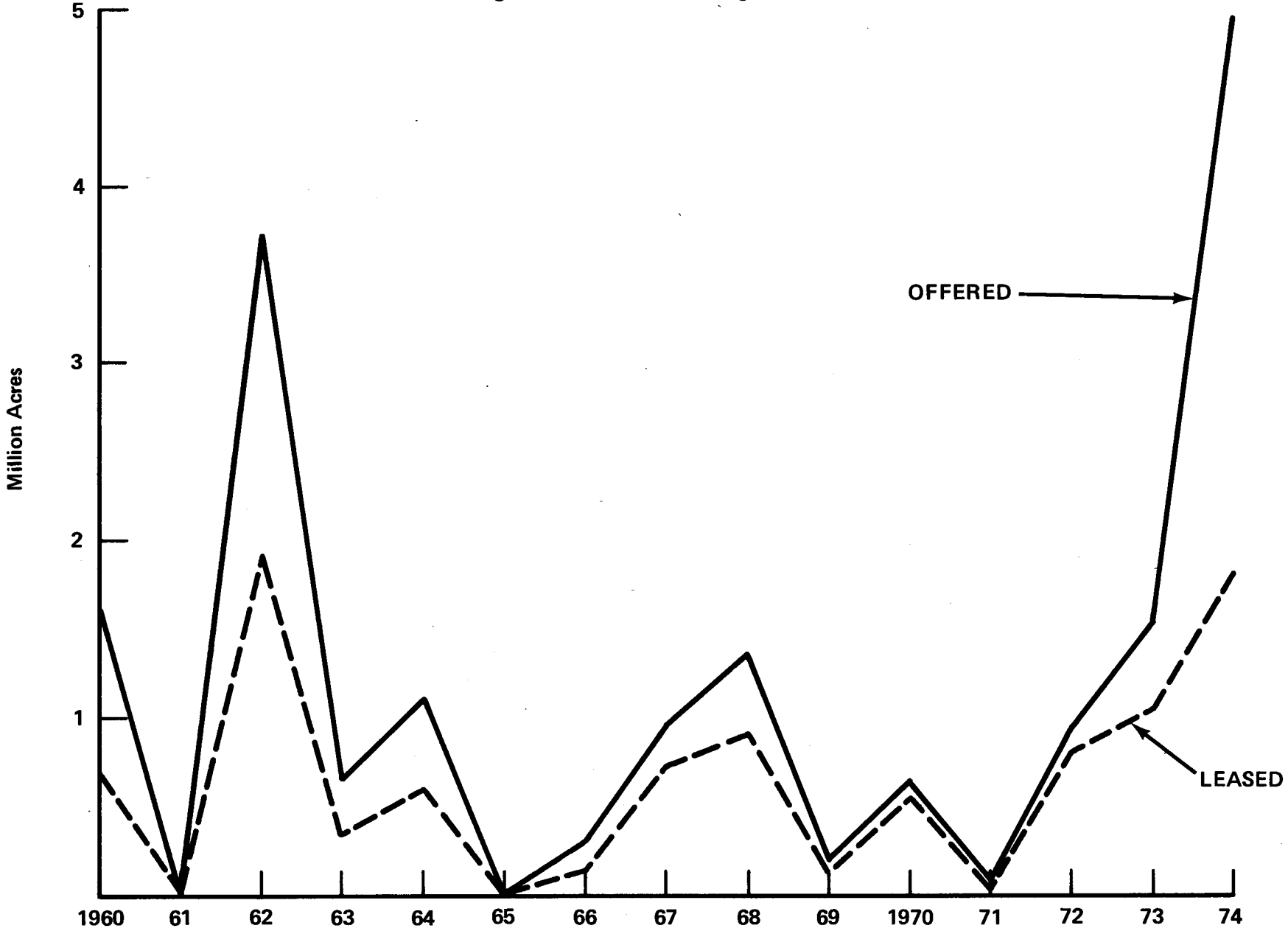
In 1975, the Department of the Interior will lease up to 10 million acres, as set forth by the President in his directive in 1974.

**Federal OCS Oil and Gas Leases**

| YEAR | ACRES OFFERED | ACRES LEASED | PERCENT LEASED |
|---|---|---|---|
| 1960 | 1,610,983 | 704,526 | 44 |
| 1961 | NO SALES | NO SALES | --- |
| 1962 | 3,713,116 | 1,924,535 | 52 |
| 1963 | 669,777 | 312,945 | 47 |
| 1964 | 1,124,102 | 613,526 | 55 |
| 1965 | NO SALES | NO SALES | --- |
| 1966 | 265,886 | 141,768 | 53 |
| 1967 | 971,489 | 744,456 | 77 |
| 1968 | 1,315,984 | 934,167 | 71 |
| 1969 | 190,153 | 108,653 | 57 |
| 1970 | 666,845 | 596,040 | 89 |
| 1971 | 55,872 | 37,222 | 67 |
| 1972 | 970,711 | 826,195 | 85 |
| 1973 | 1,514,940 | 1,032,570 | 68 |
| 1974 | 4,955,366 | 1,762,158 | 36 |

# Federal OCS Oil and Gas Leases, 1960-74

(Acreage Offered and Acreage Leased)



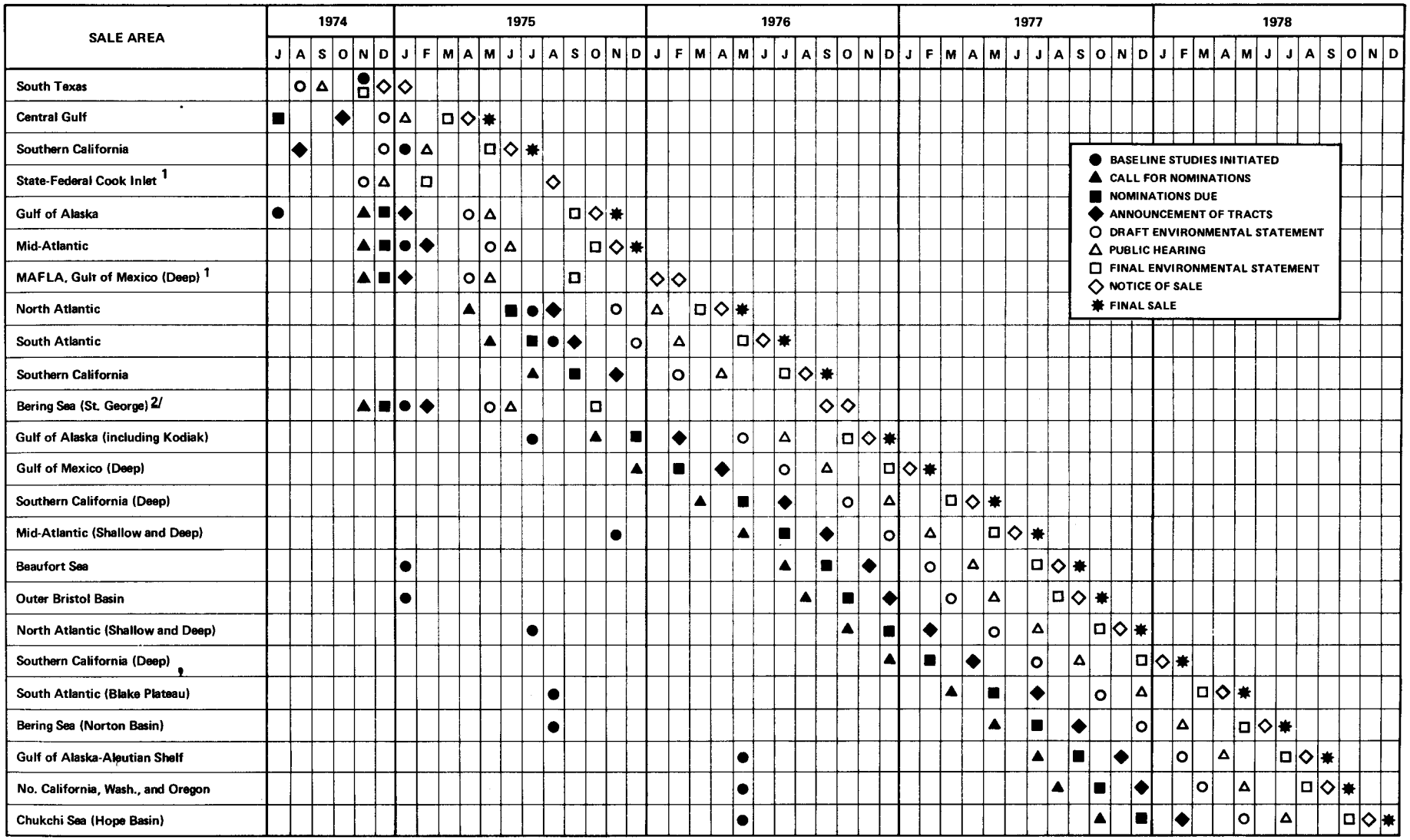

Source: U.S. Geological Survey, 1974.

# Proposed OCS Leasing Schedule

A matrix representing a proposed leasing schedule for 24 areas of the Outer Continental Shelf (OCS) during the period from July 1974 through 1978 is presented on the following page.

The schedule calls for six Federal sales each year through 1978, with the first sale in frontier areas in February 1975 off the South Texas coast.

# Proposed OCS Leasing Schedule, July 1974-78[2]




[1]With the Supreme Court decision still pending on U.S. versus Maine, et al., the first sale in the Mid-Atlantic will have to be deferred until the spring or summer of 1976. The MAFLA (Deep) sale may be scheduled in December 1975, rather than February of 1976, to replace the Mid-Atlantic sale.

[2]All the final sale dates are tentative pending satisfactory completion of final environmental impact statements.

Source: U.S. Bureau of Land Management, 1974.

# Federal OCS Bonuses and Royalties

Since 1960, $14,455.1 million in Outer Continental Shelf (OCS) bonuses have been paid into the U.S. treasury.

This compares to a cumulative total of $2,974.6 million received from OCS royalties during this period.

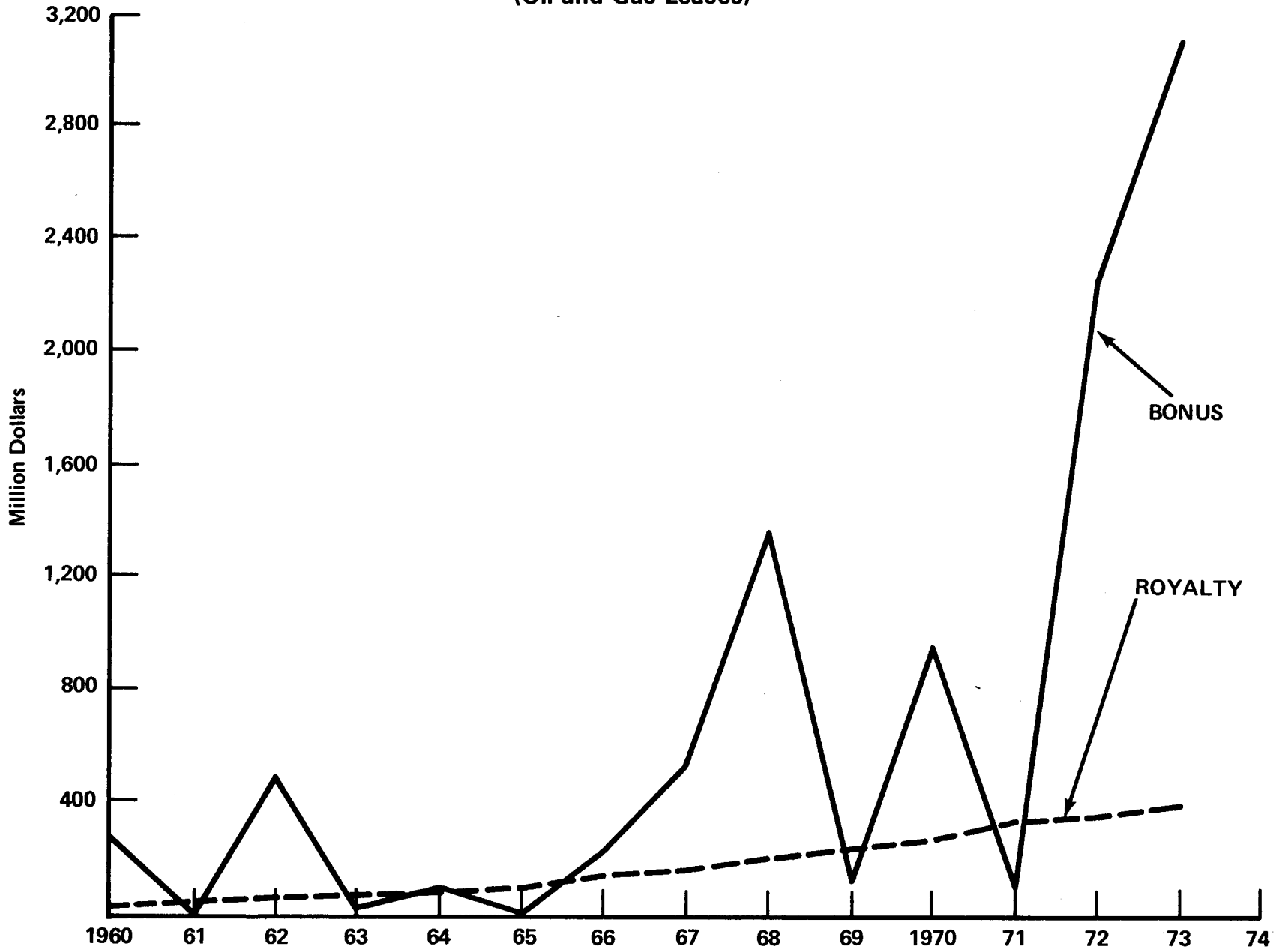
In 1974, Federal OCS bonuses reached a level of $5,022.9 million, a 66-percent increase since 1973. OCS royalties increased 46 percent over 1973.

**Federal OCS Bonuses and Royalties, 1960-74**
**(Millions of Dollars)**

| YEAR | BONUSES | ROYALTIES |
|---|---|---|
| 1960 | 282.6 | 36.8 |
| 1961 | 0 | 46.7 |
| 1962 | 489.5 | 65.3 |
| 1963 | 12.8 | 75.3 |
| 1964 | 95.9 | 86.5 |
| 1965 | 0 | 99.7 |
| 1966 | 209.2 | 131.3 |
| 1967 | 510.1 | 149.1 |
| 1968 | 1,346.5 | 190.9 |
| 1969 | 110.9 | 226.5 |
| 1970 | 944.6 | 262.7 |
| 1971 | 96.3 | 324.8 |
| 1972 | 2,251.3 | 342.5 |
| 1973 | 3,082.5 | 380.5 |
| 1974 | 5,022.9 | 556.0 |

# Federal OCS Bonuses and Royalties, 1960-73

(Oil and Gas Leases)




Source: U.S. Geological Survey, 1974.

# U.S. Offshore Oil Well Drilling Depths and Estimated Costs

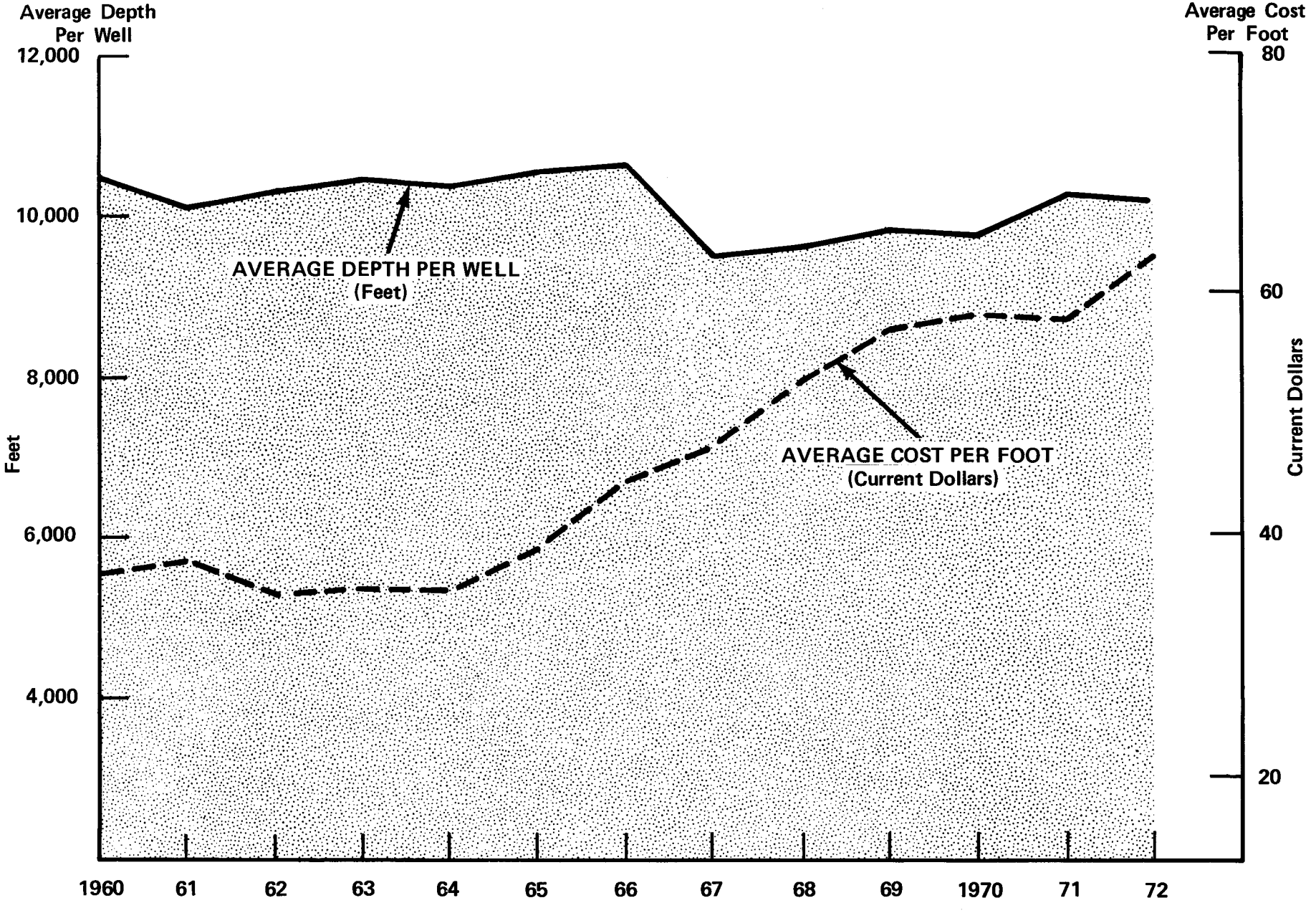
From 1960 to 1972, the average cost per foot of drilling and equipping offshore wells in the United States increased at an annual rate of 4.6 percent.

The number of offshore wells drilled increased at an annual rate of 5.2 percent during the 1960-72 period.

**U.S. Offshore Oil Well Drilling Depths and Estimated Costs, 1960-72**

| YEAR | OFFSHORE WELLS DRILLED | FOOTAGE (000's Ft.) | COST ($000's) | AVERAGE DEPTH PER WELL (Feet) | AVERAGE COST PER WELL (Dollars) | AVERAGE COST PER FOOT (Dollars) |
|---|---|---|---|---|---|---|
| 1960 | 538 | 5,608 | 207,518 | 10,424 | 385,722 | 37.00 |
| 1961 | 606 | 6,084 | 231,236 | 10,040 | 381,577 | 38.00 |
| 1962 | 760 | 7,755 | 271,578 | 10,204 | 357,339 | 35.02 |
| 1963 | 786 | 8,170 | 291,210 | 10,395 | 370,497 | 35.64 |
| 1964 | 995 | 10,179 | 357,752 | 10,230 | 359,549 | 35.14 |
| 1965 | 1,037 | 10,889 | 427,823 | 10,500 | 412,558 | 39.29 |
| 1966 | 1,127 | 11,870 | 531,157 | 10,533 | 471,302 | 44.75 |
| 1967 | 1,365 | 12,918 | 614,152 | 9,464 | 449,928 | 47.54 |
| 1968 | 1,322 | 12,619 | 667,603 | 9,545 | 504,994 | 52.91 |
| 1969 | 1,191 | 11,650 | 666,137 | 9,782 | 559,309 | 57.18 |
| 1970 | 1,058 | 10,238 | 598,511 | 9,677 | 565,700 | 58.46 |
| 1971 | 884 | 9,007 | 522,617 | 10,189 | 591,196 | 58.02 |
| 1972 | 993 | 10,001 | 632,449 | 10,072 | 636,908 | 63.23 |

# U.S. Offshore Oil Well Drilling Depths and Estimated Costs, 1960-72




Source: Joint Association Survey, 1973.

# OCS Production Lead Times

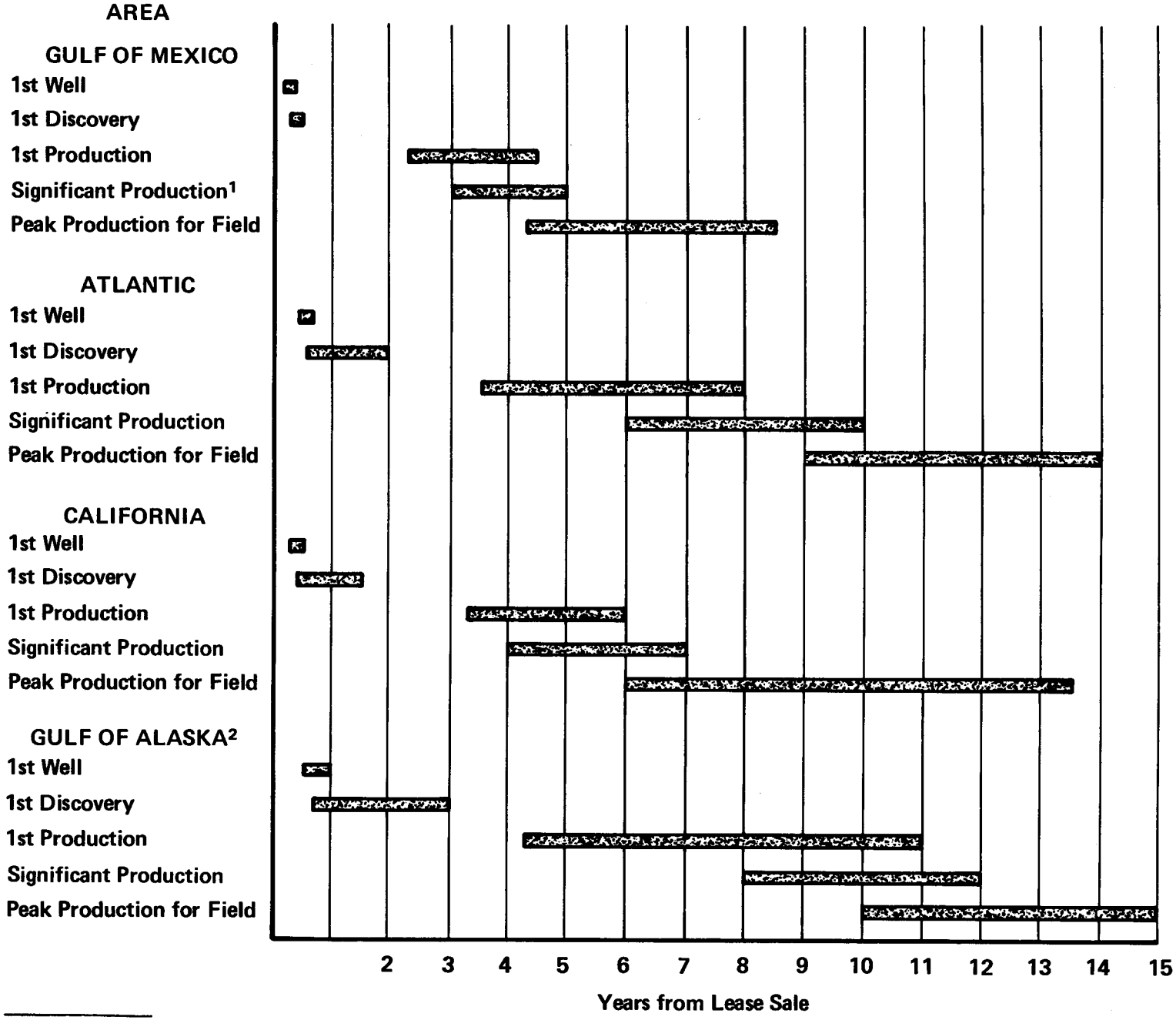
Estimated lead times for alternative Outer Continental Shelf (OCS) oil and gas lease areas are presented on the following page.

Lead times for first production and significant production of a field located in the Gulf of Mexico are considerably less than for the new frontier OCS areas, such as the Atlantic and the Gulf of Alaska.

Estimated maximum lead time until peak production in a field located in the Gulf of Alaska and in the Atlantic are 15 and 14 years, respectively, as compared to 8 to 9 years for a field located in the Gulf of Mexico.

California peak production lead times are based upon an average of Santa Barbara production, which has a 2-year lead time, and production further off the California coast, which would take considerably longer.

# OCS Production Lead Times




[1]Significant production exists when gathering systems and pipelines are constructed and connected to OCS wells.

[2]Peak production for an entire area will take 10 to 25 years.

Source: U.S. Geological Survey, 1975.

# OCS Oil Spills

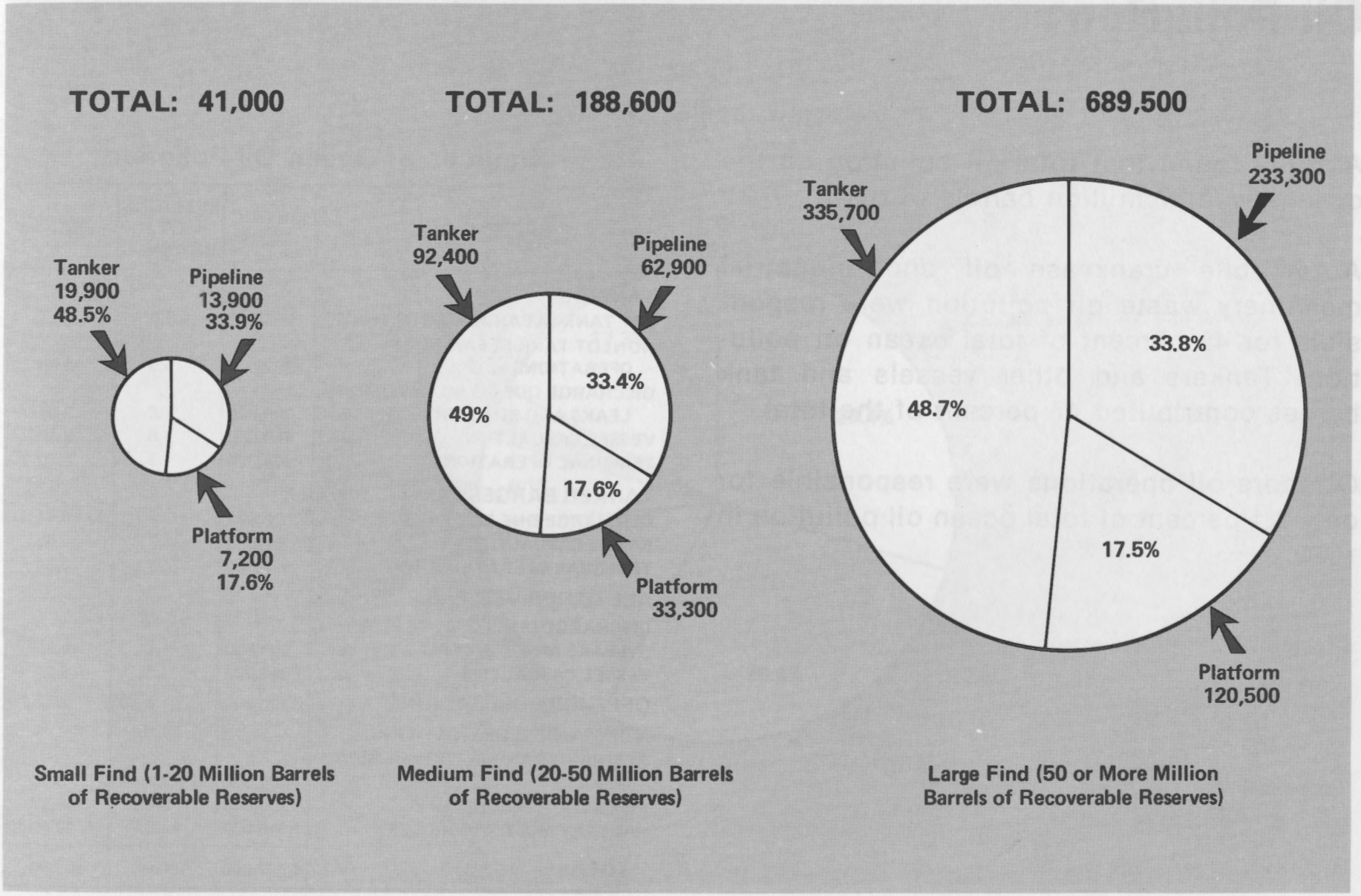
**[by Cause]**

For small, medium and large Outer Continental Shelf (OCS) fields, tanker accidents have been responsible for 49 percent of the total oil spilled in all three field sizes, while platform accidents have been responsible for 18 percent of the total oil spilled.

Massachusetts Institute of Technology found that the mean spill rate of the total volume of oil handled was .006 percent for platforms, .011 percent for offshore pipelines, and .016 percent for tankers.

# Oil Spilled Over the Life of an Average OCS Field, by Cause

(Barrels)




Source: OCS Oil and Gas: An Environmental Assessment, Council on Environmental Quality, 1974, pages 4-34, 4-35.

# Sources of Ocean Oil Pollution

A study found that total oil pollution on the oceans was 37 million barrels of oil in 1972.

Automobile crankcase oil and industrial machinery waste oil pollution were responsible for 45 percent of total ocean oil pollution. Tankers and other vessels and tank barges contributed 47 percent of the total.

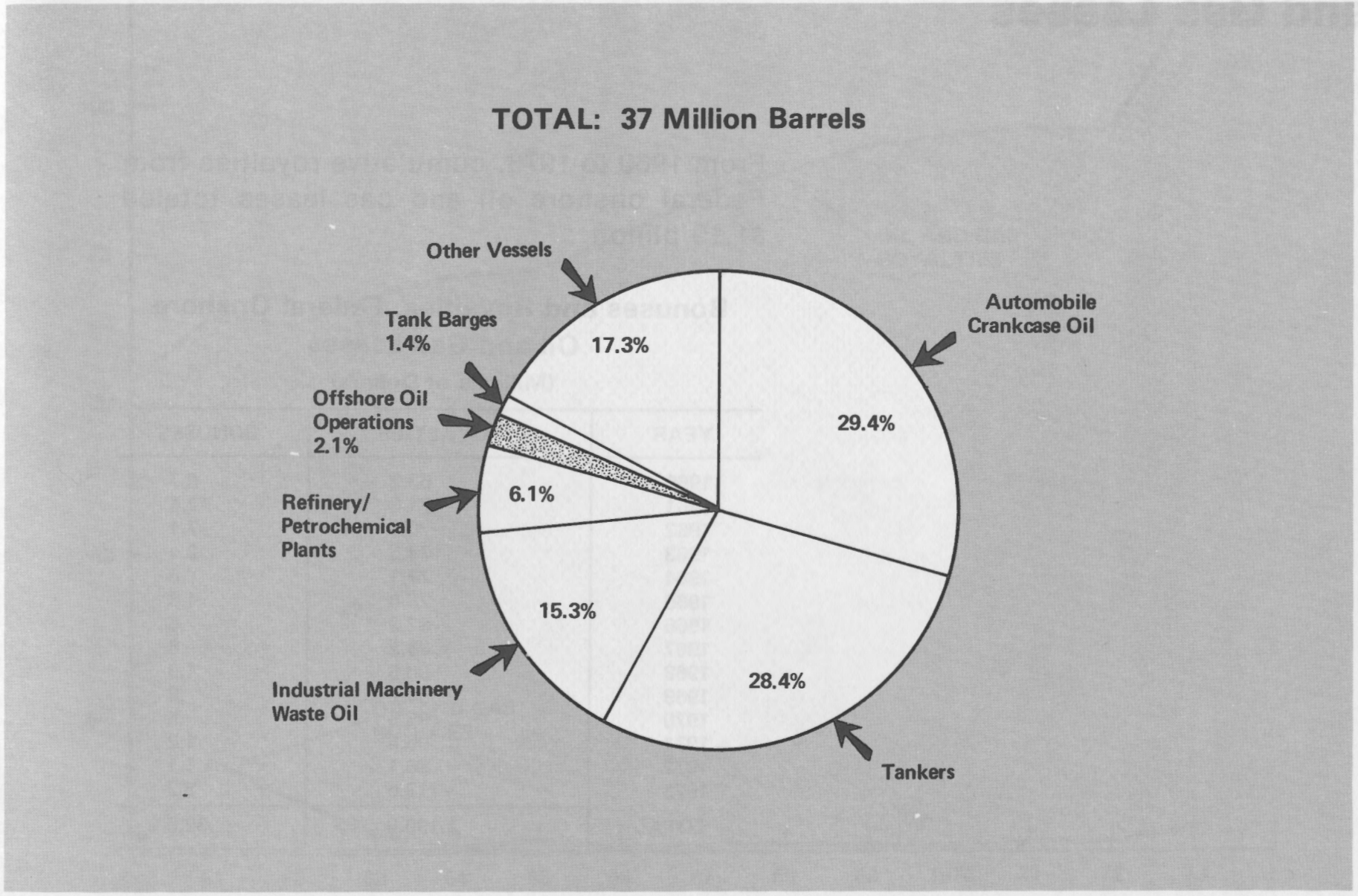
Offshore oil operations were responsible for only 2.1 percent of total ocean oil pollution in 1972.

**Sources of Ocean Oil Pollution[1]**

| OPERATION | METRIC TONS | MILLIONS OF BARRELS | PERCENT |
|---|---|---|---|
| TANKERS: | | | |
| LOT TANK CLEANING OPERATIONS | 265,000 | 2.0 | 5.44 |
| NONLOT TANK CLEANING OPERATIONS | 702,000 | 5.3 | 14.36 |
| DISCHARGE DUE TO BILGE PUMPING, LEAKS AND BUNKERING SPILLS | 100,000 | .8 | 2.04 |
| VESSEL CASUALTIES | 250,000 | 1.9 | 5.14 |
| TERMINAL OPERATIONS | 70,000 | .5 | 1.42 |
| TANKER BARGES: | | | |
| DISCHARGE DUE TO LEAKS | 20,000 | .2 | 0.41 |
| BARGE CASUALTIES | 32,000 | .2 | 0.65 |
| TERMINAL OPERATIONS | 18,000 | .1 | 0.34 |
| ALL OTHER VESSELS: | | | |
| DISCHARGE DUE TO BILGE PUMPING, LEAKS AND BUNKERING SPILLS | 600,000 | 4.5 | 12.20 |
| VESSEL CASUALTIES | 250,000 | 1.9 | 5.10 |
| OFFSHORE OPERATIONS | 100,000 | .8 | 2.10 |
| NONMARINE OPERATIONS: | | | |
| REFINERIES AND PETRO-CHEMICAL PLANTS | 300,000 | 2.3 | 6.10 |
| INDUSTRIAL MACHINERY | 750,000 | 5.6 | 15.30 |
| HIGHWAY MOTOR VEHICLES | 1,440,000 | 10.8 | 29.40 |
| TOTAL | 4,897,000 | 100.0 | 100.00 |

[1] The pollution total does not include oil contributed by recreational boats, hydrocarbon fallout, and natural seepage.

# Sources of Ocean Oil Pollution, 1972




Source: Porricelli, J.D., and Keith, V.F., Tankers and U.S. Energy Situation—an Economic and Environmental Analysis, 1973, page 063.

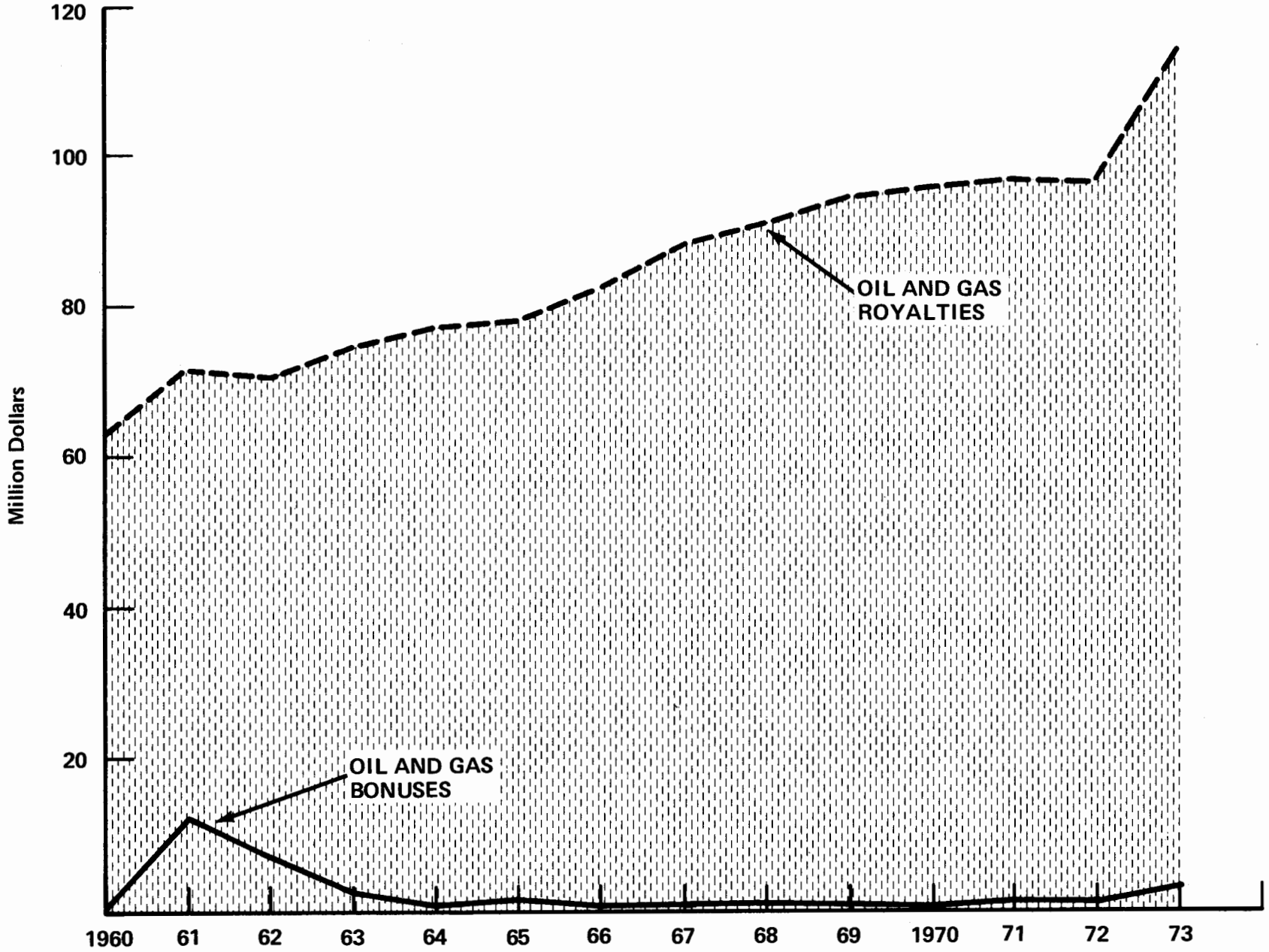
# Bonuses and Royalties Federal Onshore Oil and Gas Leases

From 1960 to 1973, cumulative royalties from Federal onshore oil and gas leases totaled $1.19 billion.

**Bonuses and Royalties, Federal Onshore Oil and Gas Leases**
**(Millions of Dollars)**

| YEAR | ROYALTIES | BONUSES |
|---|---|---|
| 1960 | 63.2 | 0.7 |
| 1961 | 71.3 | 12.4 |
| 1962 | 70.1 | 7.1 |
| 1963 | 74.5 | 2.1 |
| 1964 | 77.1 | .6 |
| 1965 | 78.0 | 1.8 |
| 1966 | 82.2 | .6 |
| 1967 | 88.2 | .8 |
| 1968 | 90.5 | 1.0 |
| 1969 | 94.2 | .8 |
| 1970 | 95.5 | .5 |
| 1971 | 96.4 | 1.2 |
| 1972 | 96.1 | 1.1 |
| 1973 | 113.5 | 2.2 |
| TOTAL | 1,190.0 | 32.9 |

# Bonuses and Royalties, Federal Onshore Oil and Gas Leases, 1960-73




Source: U.S. Geological Survey, 1974.

# U.S. Petroleum Production

## [Federal Onshore and Indian Lands]

Petroleum production[1] on Federal onshore and Indian lands increased at a 1.8-percent annual rate from 1960 to 1967, and has declined at a 2.9-percent annual rate since 1967.

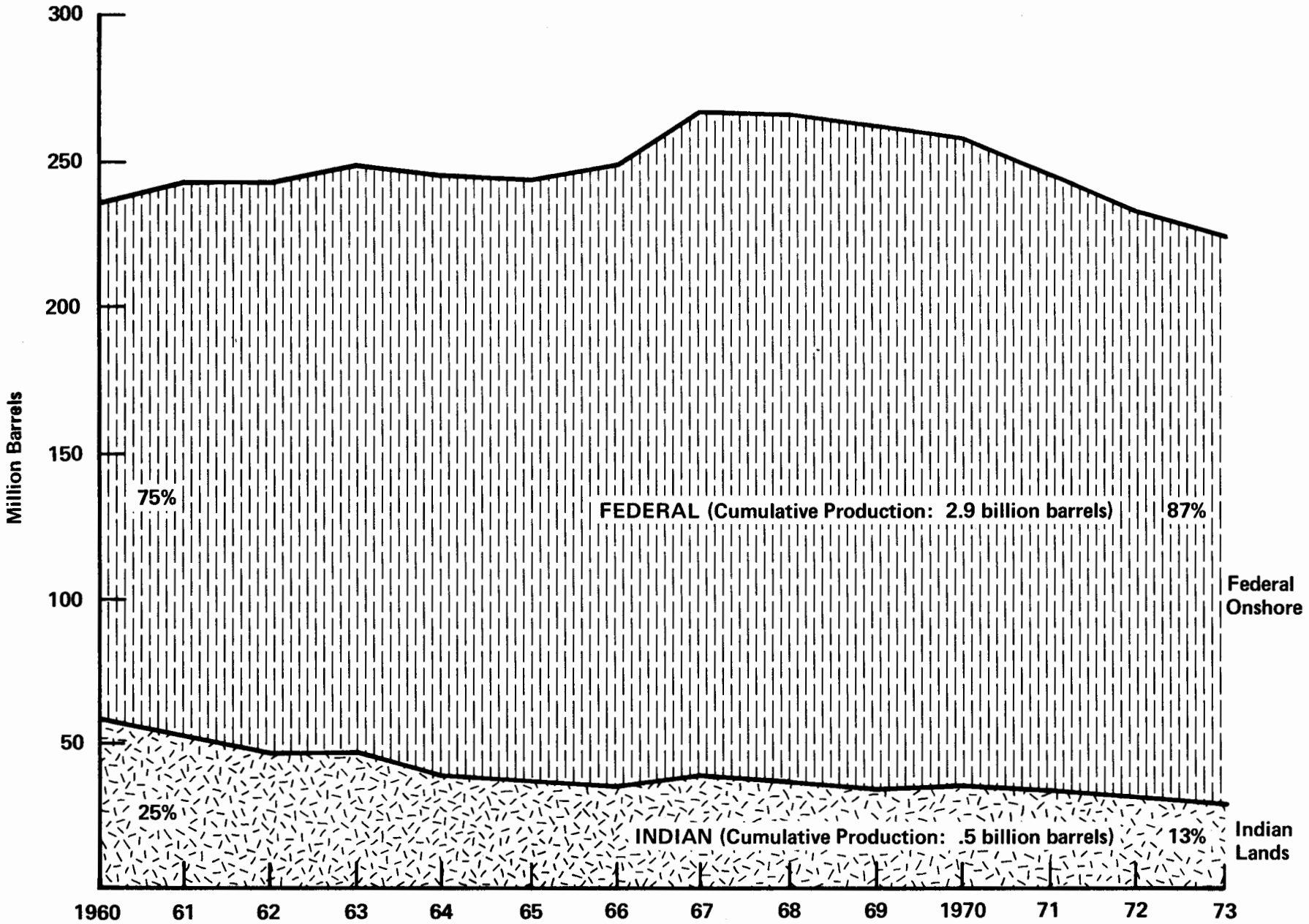
In 1973, petroleum production on Federal onshore and Indian lands constituted 6 percent of total U.S. petroleum production.

**U.S. Petroleum Production on Federal Onshore and Indian Lands**
**(Millions of Barrels)**

| YEAR | FEDERAL ONSHORE | INDIAN LANDS | TOTAL |
|---|---|---|---|
| 1960 | 176 | 59 | 235 |
| 1961 | 191 | 51 | 242 |
| 1962 | 195 | 47 | 242 |
| 1963 | 202 | 47 | 249 |
| 1964 | 205 | 39 | 244 |
| 1965 | 207 | 36 | 243 |
| 1966 | 214 | 35 | 249 |
| 1967 | 229 | 38 | 267 |
| 1968 | 229 | 36 | 265 |
| 1969 | 229 | 33 | 262 |
| 1970 | 224 | 34 | 258 |
| 1971 | 212 | 33 | 245 |
| 1972 | 201 | 31 | 232 |
| 1973 | 195 | 29 | 224 |

[1] Includes crude oil production, condensate, and natural gas liquids. Approximately one-sixth of total petroleum production consists of natural gas liquids.

# U.S. Petroleum Production on Federal Onshore and Indian Lands, 1960-73




Source: U.S. Geological Survey, 1974.

# Available Drilling Rigs Onshore and OCS

The total number of active and idle Outer Continental Shelf (OCS) mobile rigs in the United States as of January 1975 was 72. Since August 1974, one mobile rig moved overseas.

The 1976 projection for OCS mobile rigs assumes that 10 percent of the mobile rigs that are operating in foreign waters will return to the United States.

In 1971, the utilization rate — the proportion of active to workable rigs — was 75 percent for onshore rigs; it is now above 80 percent.

# Available Drilling Rigs, Onshore and OCS

| | | | | | | |
|---|---|---|---|---|---|---|
| OCS MOBILE RIGS IN FEDERAL AND STATE WATERS | STATUS | AREA | AUG. 1971 | AUG. 1973 | AUG. 1974 | AUG. 1976 |
| | ACTIVE | LOUISIANA | 51 | 58 | 45 | |
| | | TEXAS | 0 | 4 | 13 | |
| | | ALABAMA | 0 | 0 | 1 | 111 |
| | | FLORIDA | 0 | 0 | 1 | |
| | | U. S. PACIFIC | 0 | 3 | 3 | |
| | IDLE | | 9 | 11 | 10 | 20 |
| | TOTAL | | 60 | 76 | 73 | 131 |
| ONSHORE RIGS | ACTIVE | | 896 | 1103 | 1400 | 1455 |
| | IDLE | | 299 | 473 | 287 | 298 |
| | TOTAL | | 1195 | 1576 | 1687 | 1753 |

Source: Draft Report, Oil Resource Task Force, Project Independence Report, August 1974; U.S. Department of the Interior, 1974.

# U.S. Oil and Gas Wells Drilled

From 1965 to 1973, the number of wells drilled in the United States declined at a 5-percent annual rate. While oil wells declined 7.7 percent annually, gas wells increased at an annual rate of 3.8 percent. Between 1965 and 1970, however, gas wells drilled declined at an annual rate of 4.2 percent.

Dry wells constituted 41 percent of total wells drilled (exclusive of service wells) in the United States in 1965 and 39 percent of the total in 1973.

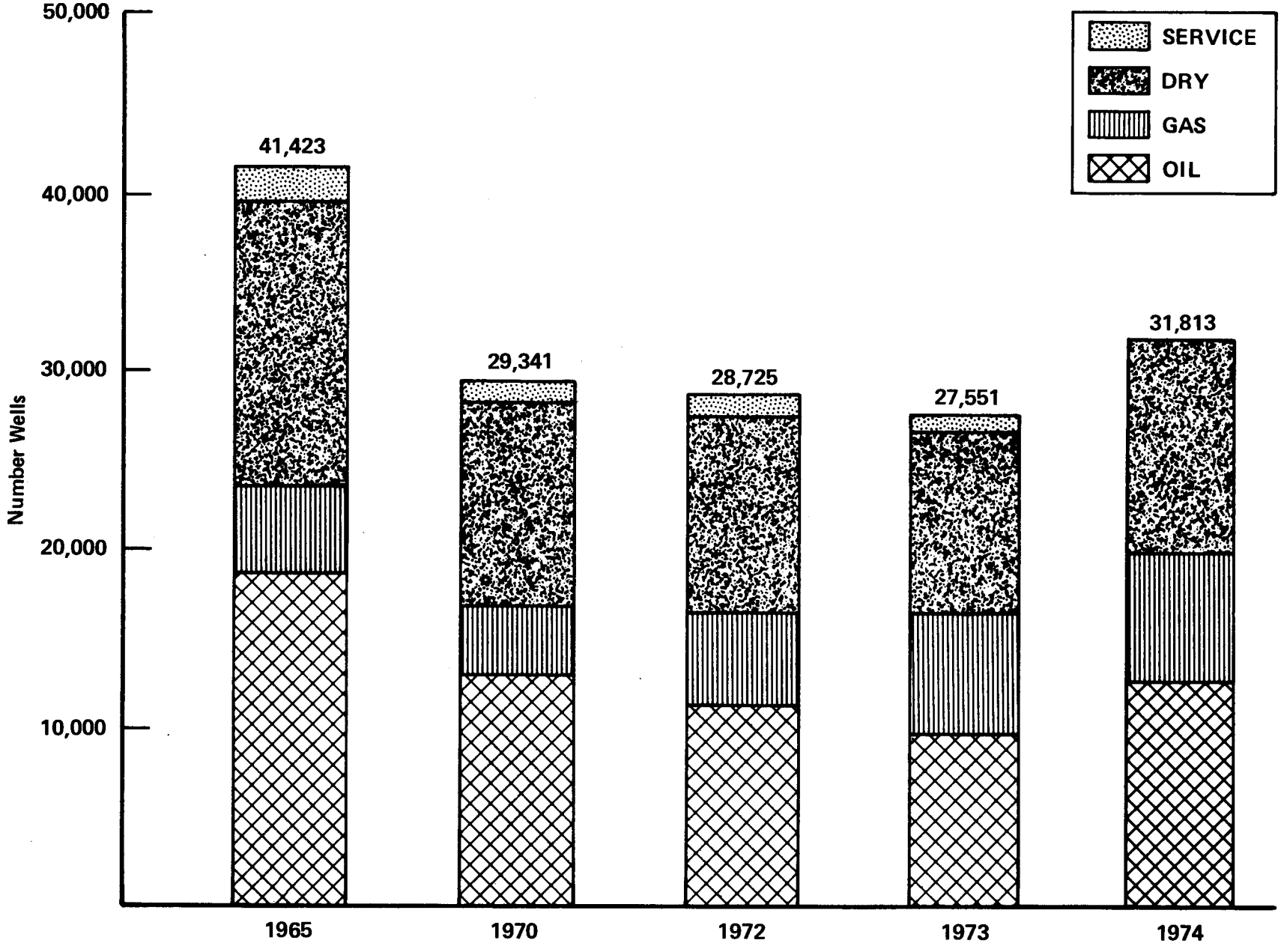
Oil wells constituted 45 percent of total wells drilled in the United States in 1965, and 36 percent of the total in 1973.

In 1974, the number of wells drilled, excluding service wells, increased by 5,221, a 20-percent increase.

**U.S. Oil and Gas Wells Drilled, 1965-74**

| TYPE | 1965 | 1970 | 1972 | 1973 | 1974 (Preliminary) |
|---|---|---|---|---|---|
| OIL | 18,761 | 13,020 | 11,306 | 9,902 | 12,722 |
| GAS | 4,724 | 3,840 | 4,928 | 6,385 | 7,196 |
| DRY | 16,016 | 11,260 | 11,057 | 10,305 | 11,895 |
| SERVICE | 1,922 | 1,221 | 1,434 | 954 | |
| TOTAL | 41,423 | 29341 | 28,725 | 27,551 | 31,813 |
| DRY HOLES AS PERCENT OF TOTAL (Exclusive of Service Wells) | 40.5 | 40.0 | 40.5 | 38.8 | 37.4 |

# U.S. Oil and Gas Wells Drilled, 1965-74




Source: Oil and Gas Journal, 1965; 1970-73, Quarterly Review of Drilling Statistics, American Petroleum Institute.

# U.S. Exploratory Oil and Gas Wells

Total exploratory wells in the United States increased at an annual rate of 7.8 percent from 1950 to 1956, but declined 4.5 percent annually from 1956 to 1973.

In 1973, dry exploratory wells constituted 80 percent of total exploratory wells.

Total new-field wildcats increased 8.7 percent annually from 1950 to 1956, but declined 3 percent annually from 1956 to 1973.

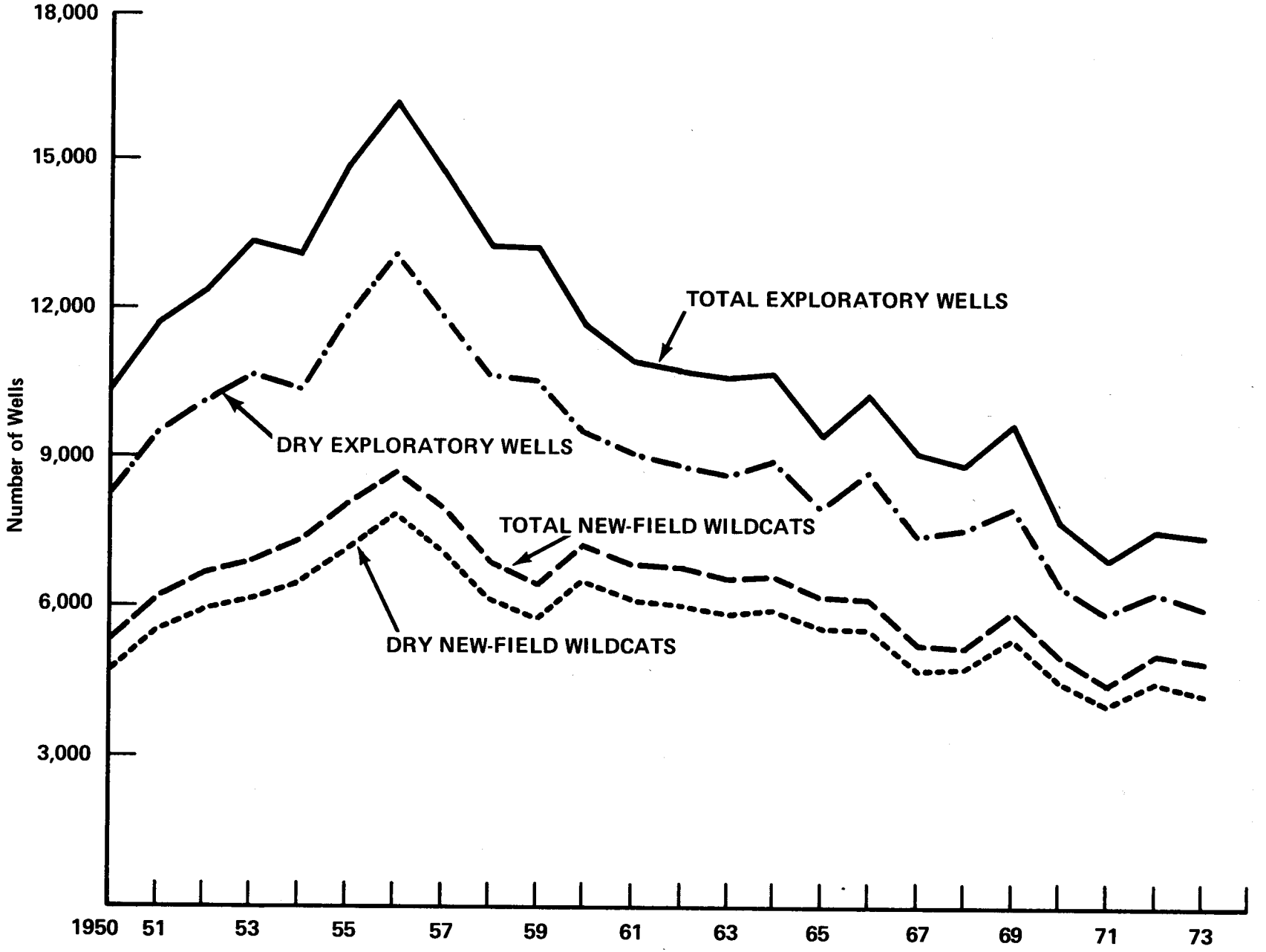
In 1974 the preliminary estimate of total exploratory wells drilled in the United States in 1974 is 8,723.

**U.S. Exploratory Oil and Gas Wells, 1950-73**

| YEAR | TOTAL, ALL EXPLORATORY WELLS[1] | NUMBER OF DRY EXPLORATORY WELLS | PERCENT OF EXPLORATORY WELLS THAT WERE DRY | TOTAL NEW-FIELD WILDCATS (Strict Wildcats) | NUMBER OF DRY NEW-FIELD WILDCATS | PERCENT NEW-FIELD WILDCATS THAT WERE DRY |
|---|---|---|---|---|---|---|
| 1950 | 10,306 | 8,292 | 80.5 | 5,290 | 4,698 | 88.8 |
| 1951 | 11,756 | 9,539 | 81.1 | 6,189 | 5,505 | 88.9 |
| 1953 | 13,313 | 10,633 | 79.9 | 6,925 | 6,151 | 88.8 |
| 1955 | 14,937 | 11,832 | 79.2 | 8,104 | 7,186 | 88.7 |
| 1957 | 14,707 | 11,897 | 80.9 | 8,014 | 7,142 | 89.1 |
| 1959 | 13,191 | 10,577 | 80.2 | 6,473 | 5,736 | 88.6 |
| 1961 | 10,992 | 9,022 | 82.1 | 6,909 | 6,164 | 89.2 |
| 1963 | 10,664 | 8,686 | 81.5 | 6,570 | 5,801 | 88.3 |
| 1965 | 9,466 | 8,005 | 84.6 | 6,182 | 5,544 | 89.7 |
| 1967 | 9,059 | 7,464 | 82.4 | 5,271 | 4,727 | 89.7 |
| 1969 | 9,701 | 8,001 | 82.5 | 5,956 | 5,421 | 91.0 |
| 1971 | 6,922 | 5,834 | 84.3 | 4,462 | 4,028 | 90.3 |
| 1973 | 7,466 | 5,947 | 79.6 | 4,989 | 4,288 | 85.9 |

[1] Total new-field wildcats, new-pool wells, and extension wells.

# U.S. Exploratory Oil and Gas Wells, 1950-73




Source: American Petroleum Institute, 1970-73; American Association of Petroleum Geologists, 1938-55, 1959-69; Oil and Gas Journal, 1956-58.

# U.S. Oil Well Drilling Depths and Estimated Costs

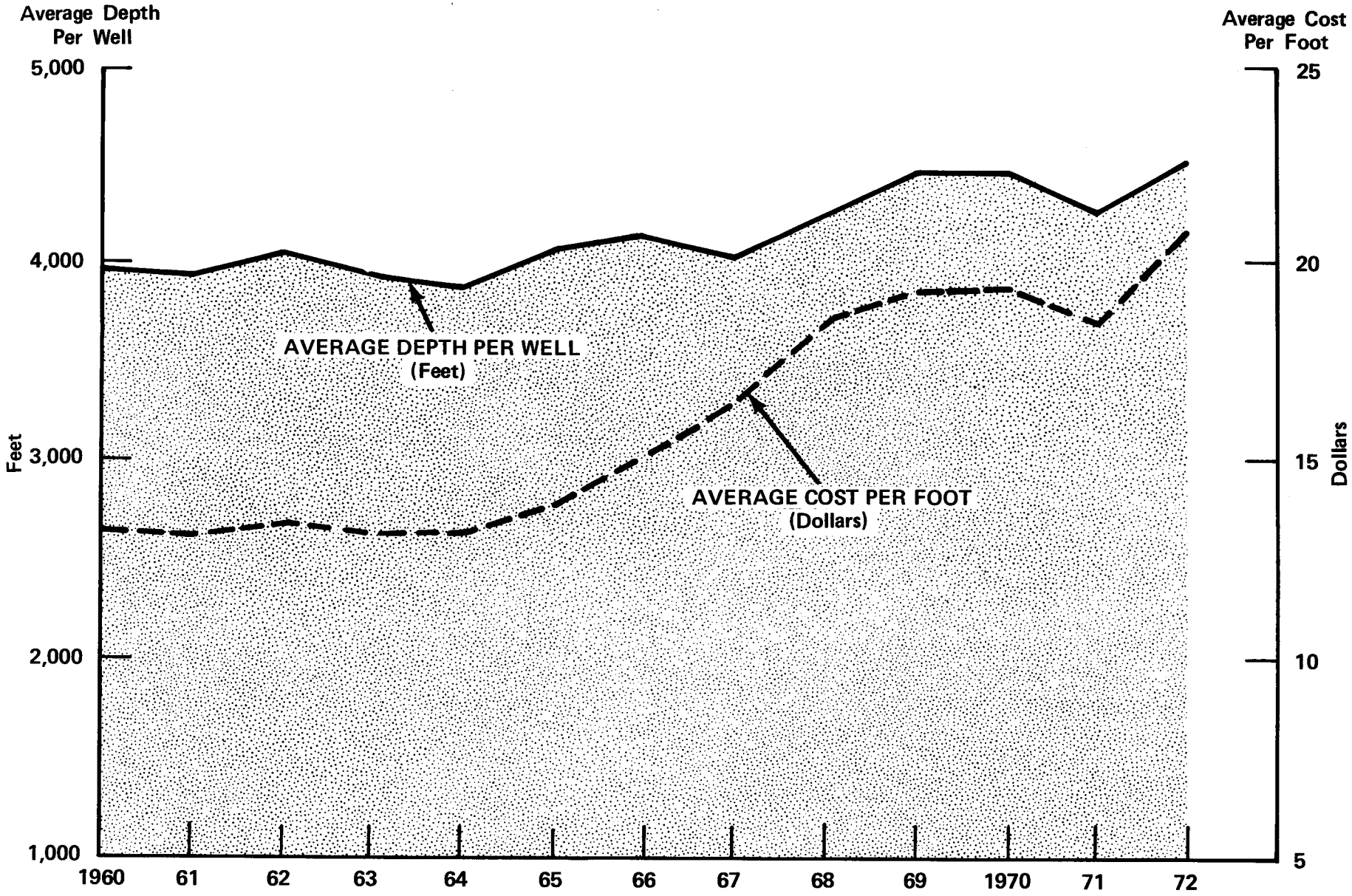
Between 1960 and 1972, the average depth per oil well increased 14 percent, from 3,946 to 4,501 feet. The average cost per foot of well drilled increased 57 percent during this period, reflecting in part the increase in the average depth of oil wells drilled.

During the period from 1960 to 1972, the number of oil wells drilled declined at an annual rate of 5.5 percent, and the average cost per foot drilled increased at an annual rate of 3.8 percent.

**U.S. Oil Well Drilling Depths and Estimated Costs**

| YEAR | OIL WELLS DRILLED | FOOTAGE (000's Ft.) | COST ($000's) | AVERAGE DEPTH PER WELL (Feet) | AVERAGE COST PER WELL (Dollars) | AVERAGE COST PER FOOT (Dollars) |
|---|---|---|---|---|---|---|
| 1960 | 21,294 | 84,034 | 1,110,701 | 3,946 | 52,100 | 13.21 |
| 1961 | 21,204 | 82,924 | 1,086,762 | 3,911 | 51,253 | 13.11 |
| 1962 | 21,402 | 86,494 | 1,160,472 | 4,041 | 54,223 | 13.41 |
| 1963 | 20,678 | 81,100 | 1,071,138 | 3,922 | 51,801 | 13.20 |
| 1964 | 21,012 | 80,989 | 1,062,995 | 3,854 | 50,589 | 13.12 |
| 1965 | 18,857 | 76,548 | 1,066,796 | 4,059 | 56,573 | 13.94 |
| 1966 | 15,856 | 65,554 | 985,754 | 4,134 | 62,169 | 15.04 |
| 1967 | 14,935 | 59,934 | 995,369 | 4,013 | 66,647 | 16.61 |
| 1968 | 13,767 | 58,457 | 1,089,328 | 4,246 | 79,126 | 18.63 |
| 1969 | 12,915 | 57,934 | 1,117,129 | 4,486 | 86,499 | 19.28 |
| 1970 | 12,547 | 56,417 | 1,088,057 | 4,496 | 86,718 | 19.29 |
| 1971 | 11,405 | 48,585 | 894,505 | 4,260 | 78,431 | 18.41 |
| 1972 | 10,753 | 48,399 | 1,005,471 | 4,501 | 93,506 | 20.77 |

# U.S. Oil Well Drilling Depths and Estimated Costs, 1960-72




Source: Annual Statistical Review, American Petroleum Institute, 1974.

# U.S. Recoverable Natural Gas Resources

The most significant amounts of U.S. natural gas reserves are found on the conterminous onshore and the Gulf of Mexico Outer Continental Shelf (OCS).

Sizable undiscovered recoverable gas resources, however, are located on the conterminous onshore, Alaska onshore and OCS, Gulf of Mexico OCS, and Atlantic OCS areas.

Total U.S. gas reserves range from 396.1 trillion to 516.1 trillion cubic feet. Undiscovered recoverable resources range from 1,000 trillion-2,000 trillion cubic feet.

In 1974, 21.8 trillion cubic feet of natural gas were marketed and .96 trillion cubic feet were imported.

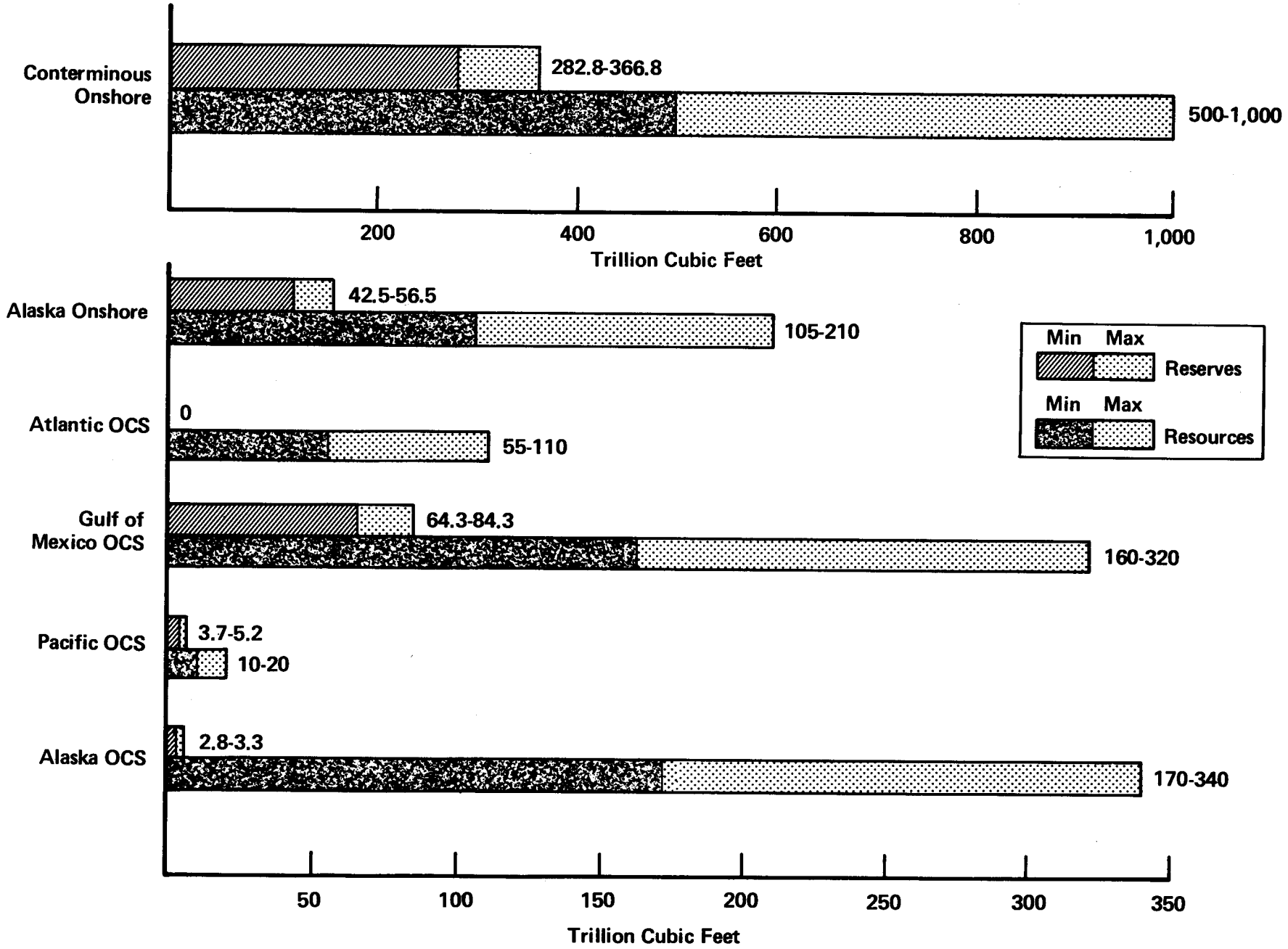
**United States Natural Gas Resources**

**(Trillions of Cubic Feet)**

| AREA | RESERVES[1] | | RESOURCES[1] | TOTALS |
|---|---|---|---|---|
| | MEASURED | INDICATED-INFERRED (RANGE) | UNDISCOVERED RECOVERABLE (RANGE) | (RANGE) |
| CONTERMINOUS STATES ONSHORE | 189.8 | 93-177.0 | 500-1,000 | 782.8-1,366.8 |
| ALASKA ONSHORE | 28.5 | 14-28.0 | 105-210 | 147.5-266.5 |
| TOTAL ONSHORE | 218.3 | 107-205.0 | 605-1,210 | 930.3-1,633.3 |
| ATLANTIC OFFSHORE | 0 | 0-0 | 55-110 | 55.0-110.0 |
| GULF OF MEXICO OFFSHORE | 43.3 | 21-41.0 | 160-320 | 224.3-404.3 |
| PACIFIC OFFSHORE | 2.7 | 1-2.5 | 10-20 | 13.7-25.2 |
| ALASKA OFFSHORE | 1.8 | 1-1.5 | 170-340 | 172.8-342.3 |
| TOTAL OFFSHORE | 47.8 | 23-45.0 | 395-790 | 465.8-881.8 |
| GRAND TOTAL | 266.1 | 130-250.0 | 1,000-2,000 | 1,396.1-2,515.1 |

[1] See glossary for definition of terms.

# U.S. Recoverable Natural Gas Resources




Source: U.S. Geological Survey, News Release, March 1974.

# U.S. Undiscovered Recoverable Natural Gas Resources

**[Alternative Estimates]**

It is evident from the following chart that the estimates of undiscovered recoverable natural gas resources[1] vary considerably, ranging from a low of 304 to a high of 2,000 trillion cubic feet.

The estimate developed by the Office of Energy Resources of the U.S. Geological Survey has been used in the text of this study.

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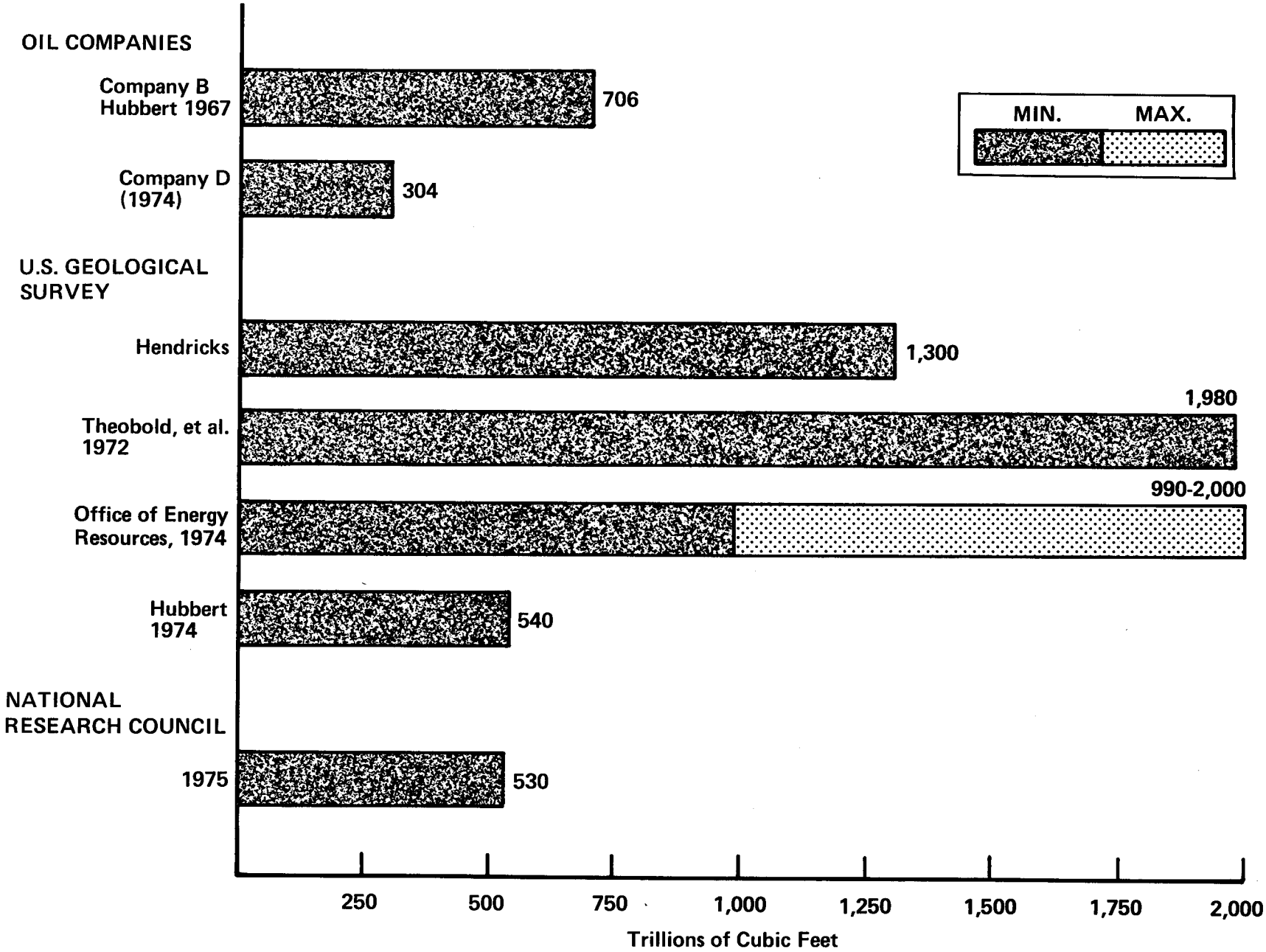
[1] Undiscovered recoverable resources are quantities of an energy commodity that may be reasonably expected to exist in favorable geologic settings, but which have not yet been identified by drilling.

# Alternative Estimates of U.S. Undiscovered Natural Gas Resources




Source: National Academy of Sciences, Mineral Resources and The Environment, 1975, page 89.

# U.S. Natural Gas Supply

The U.S. natural gas supply, consisting of domestic gas production and imports, increased at an annual rate of 4.1 percent between 1960 and 1974.

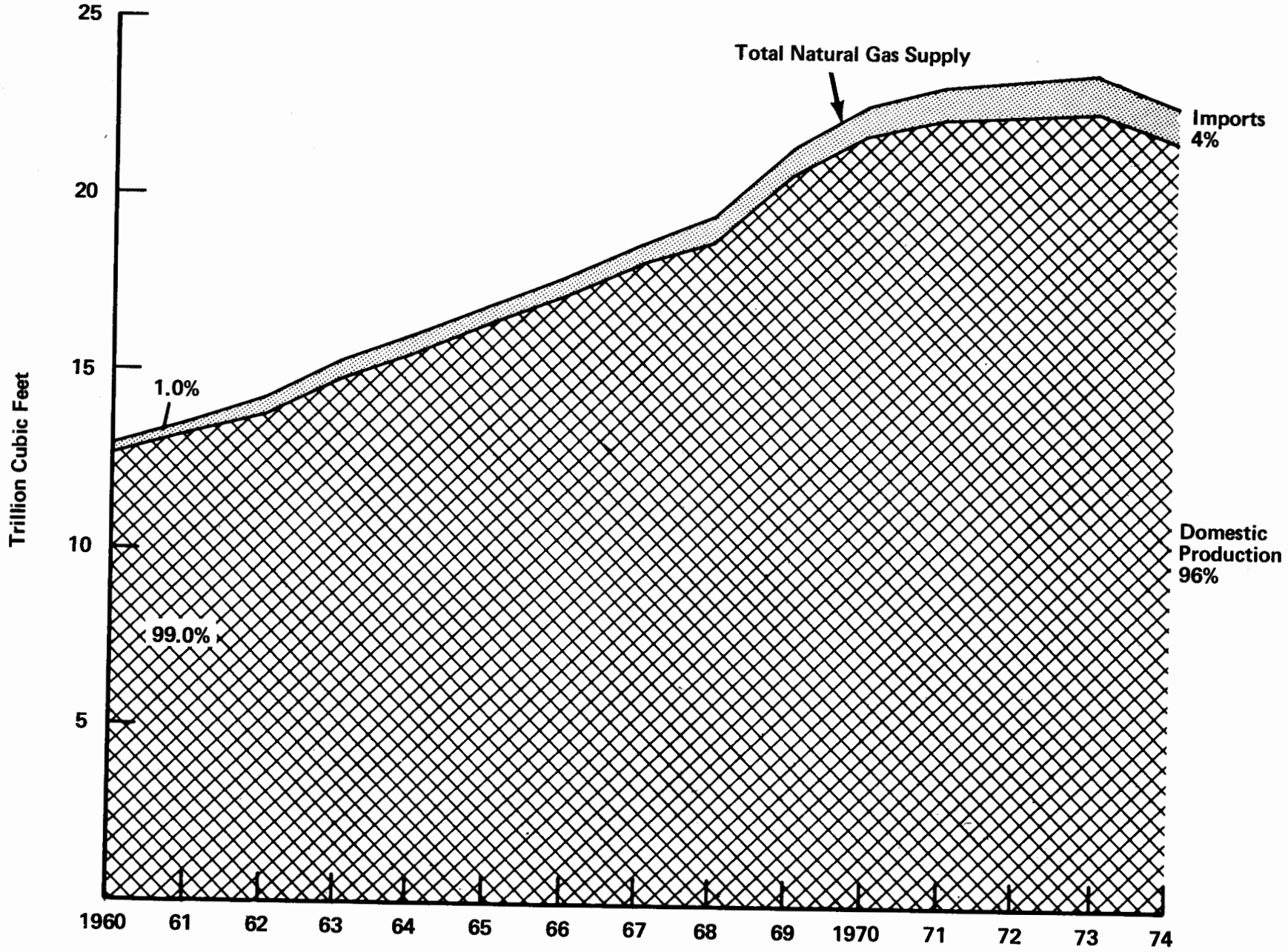
Estimated 1974 domestic natural gas production declined by 4 percent as compared to 1973, the first such decline since world War II.

**U.S. Natural Gas Supply, 1960-74**
**(Trillion Cubic Feet)**

| | YEAR | | | | ESTIMATED 1974 |
|---|---|---|---|---|---|
| | 1960 | 1965 | 1970 | 1973 | |
| DOMESTIC PRODUCTION[1] | 12.77 | 16.04 | 21.92 | 22.65 | 21.90 |
| NET IMPORTS | .14 | .43 | .75 | .96 | .86 |
| NATURAL GAS SUPPLY | 12.91 | 16.47 | 22.67 | 23.61 | 22.76 |

[1]Natural gas production refers to marketed production, namely gross withdrawals less gas used for reprocessing and quantities vented and flared.

# U.S. Natural Gas Supply, 1960-74




Source: U.S. Bureau of Mines, 1975;
Project Independence Report, 1974.

# U.S. Gross Natural Gas Production

**[Federal Onshore and Indian Lands]**

Annual natural gas production on Federal onshore and Indian lands increased at an annual rate of 4.2 percent between 1960 and 1973. The annual growth rate on Indian lands was 2.4 percent, and on Federal lands 4.5 percent during this period.

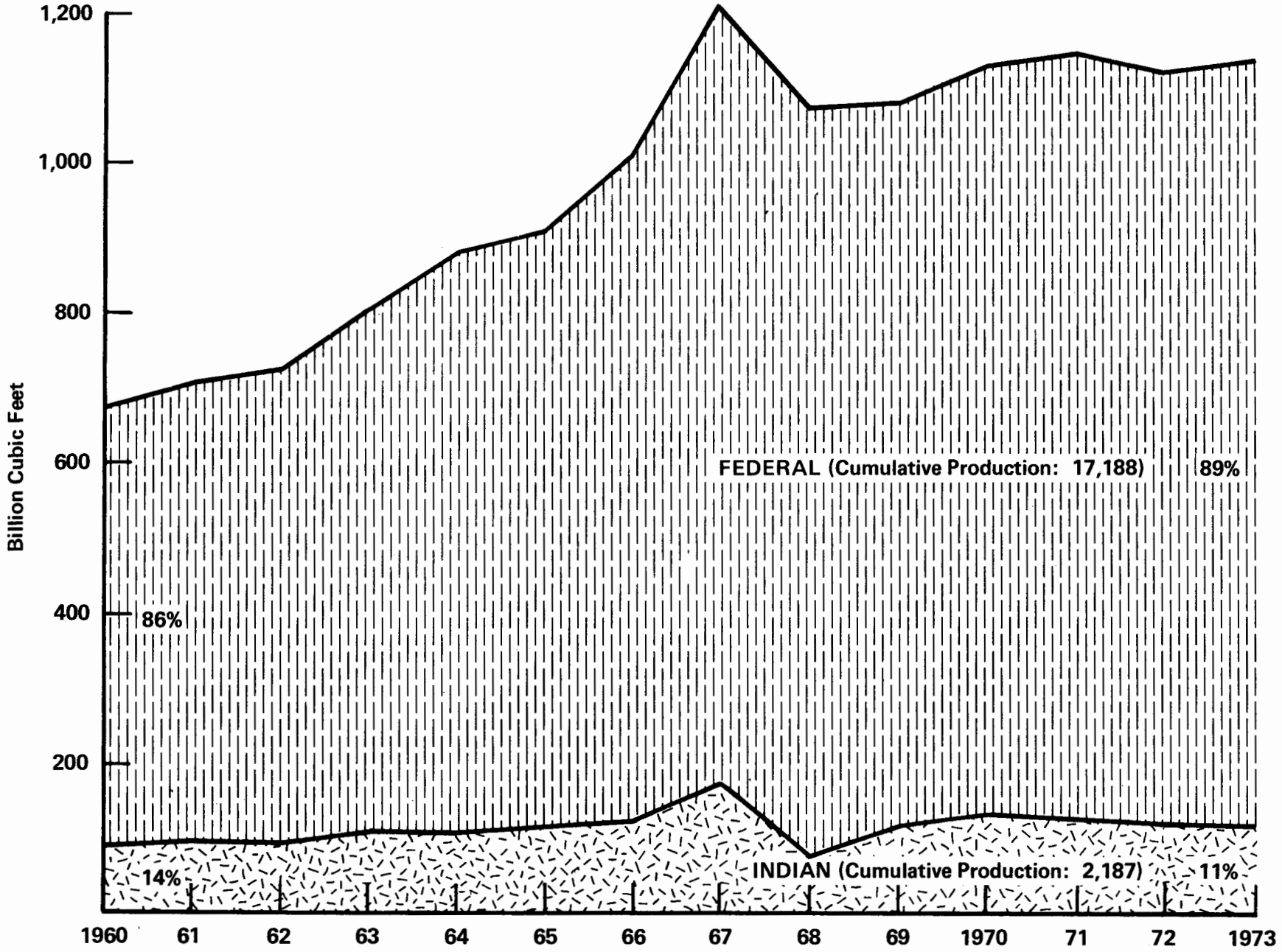
In 1973, natural gas production on Federal and Indian lands constituted 5 percent of total domestic gross natural gas production.

**U.S. Natural Gas Production, Federal Onshore and Indian Lands, 1960-73**

**(Billion Cubic Feet)**

| YEAR | FEDERAL ONSHORE | INDIAN LANDS | TOTAL |
|---|---|---|---|
| 1960 | 583 | 91 | 674 |
| 1961 | 610 | 97 | 707 |
| 1962 | 631 | 92 | 723 |
| 1963 | 698 | 105 | 803 |
| 1964 | 778 | 105 | 883 |
| 1965 | 794 | 117 | 911 |
| 1966 | 888 | 125 | 1,013 |
| 1967 | 1,040 | 177 | 1,217 |
| 1968 | 1,005 | 75 | 1,080 |
| 1969 | 963 | 125 | 1,088 |
| 1970 | 998 | 137 | 1,135 |
| 1971 | 1,043 | 130 | 1,173 |
| 1972 | 996 | 128 | 1,124 |
| 1973 | 1,028 | 124 | 1,152 |

# U.S. Gross Natural Gas Production, Federal Onshore and Indian Lands, 1960-73




Source: U.S. Geological Survey, 1974.

# Federal OCS Gross Natural Gas Production

From 1960 to 1974, gross natural gas production on the Federal Outer Continental Shelf (OCS) increased at an annual rate of 20 percent, as compared to an annual rate of increase of OCS petroleum production of 16.1 percent for this period.

Since 1971, OCS gross natural gas production has increased at an annual rate of 8.6 percent, while OCS petroleum production has declined at a 2.3-percent annual rate.

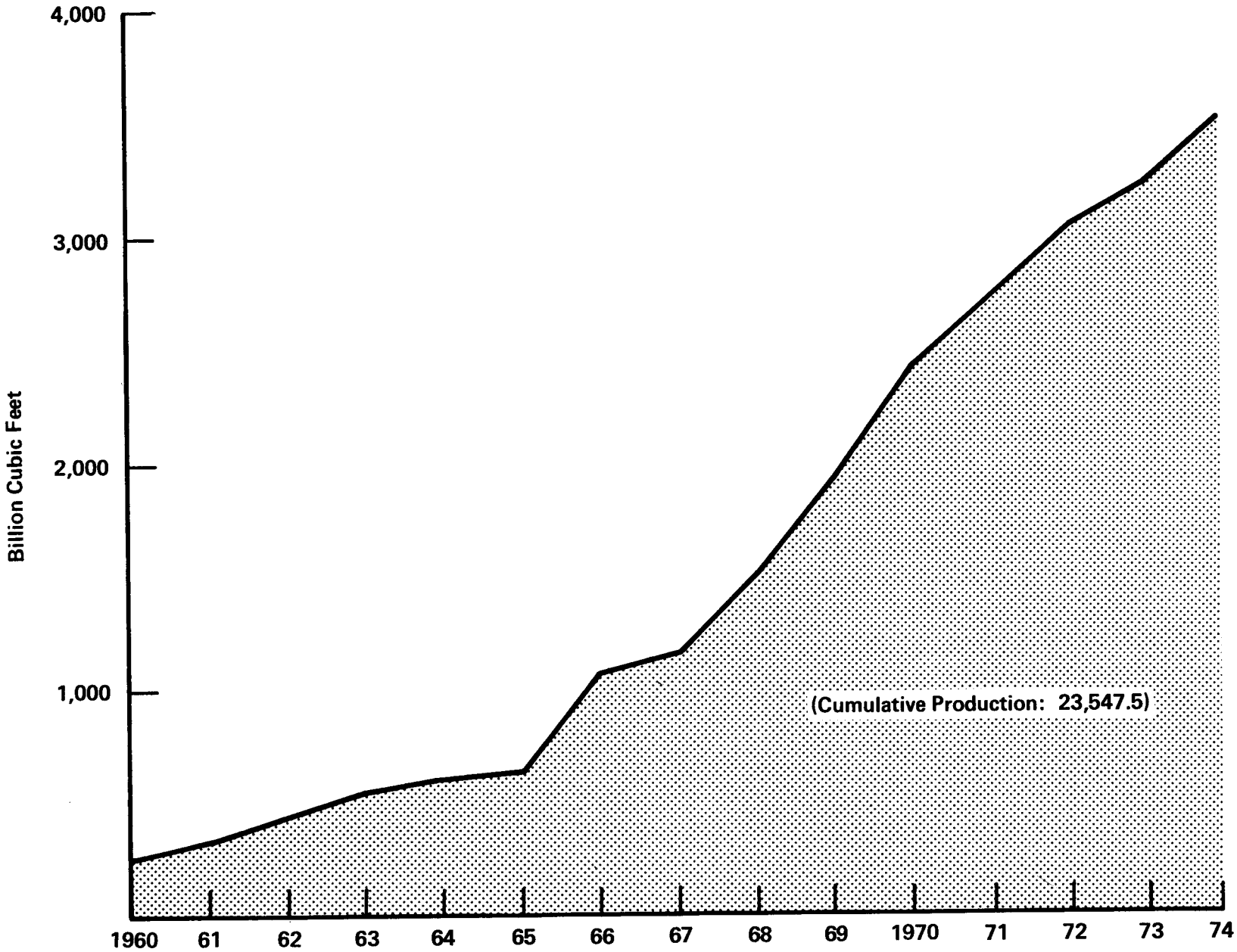
In 1974, gross natural gas production on the OCS constituted 15 percent of total domestic gross natural gas production.

**Federal OCS Gross Natural Gas Production, 1960-74**

**(Billions of Cubic Feet)**

| YEAR | AMOUNT | YEAR | AMOUNT |
|---|---|---|---|
| 1960 | 273.0 | 1968 | 1,524.5 |
| 1961 | 318.3 | 1969 | 1,954.5 |
| 1962 | 452.0 | 1970 | 2,418.7 |
| 1963 | 564.0 | 1971 | 2,777.0 |
| 1964 | 621.7 | 1972 | 3,038.6 |
| 1965 | 645.6 | 1973 | 3,211.6 |
| 1966 | 1,007.4 | 1974 | 3,553.4 |
| 1967 | 1,187.2 | | |

# Federal OCS Gross Natural Gas Production, 1960-74




Source: U.S. Geological Survey, 1974.

# Projected U.S. Marketed Natural Gas Production

**[Business as Usual, $11 Oil]**

Given business as usual, $11 oil, total U.S. marketed natural gas[1] production is projected to increase from 22.6 trillion cubic feet in 1973 to 24.1 trillion cubic feet by 1985, a .5-percent average annual increase. By 1985, the lower 48 Outer Continental Shelf would increase its share from 14 to 30 percent of total U.S. marketed natural gas production.

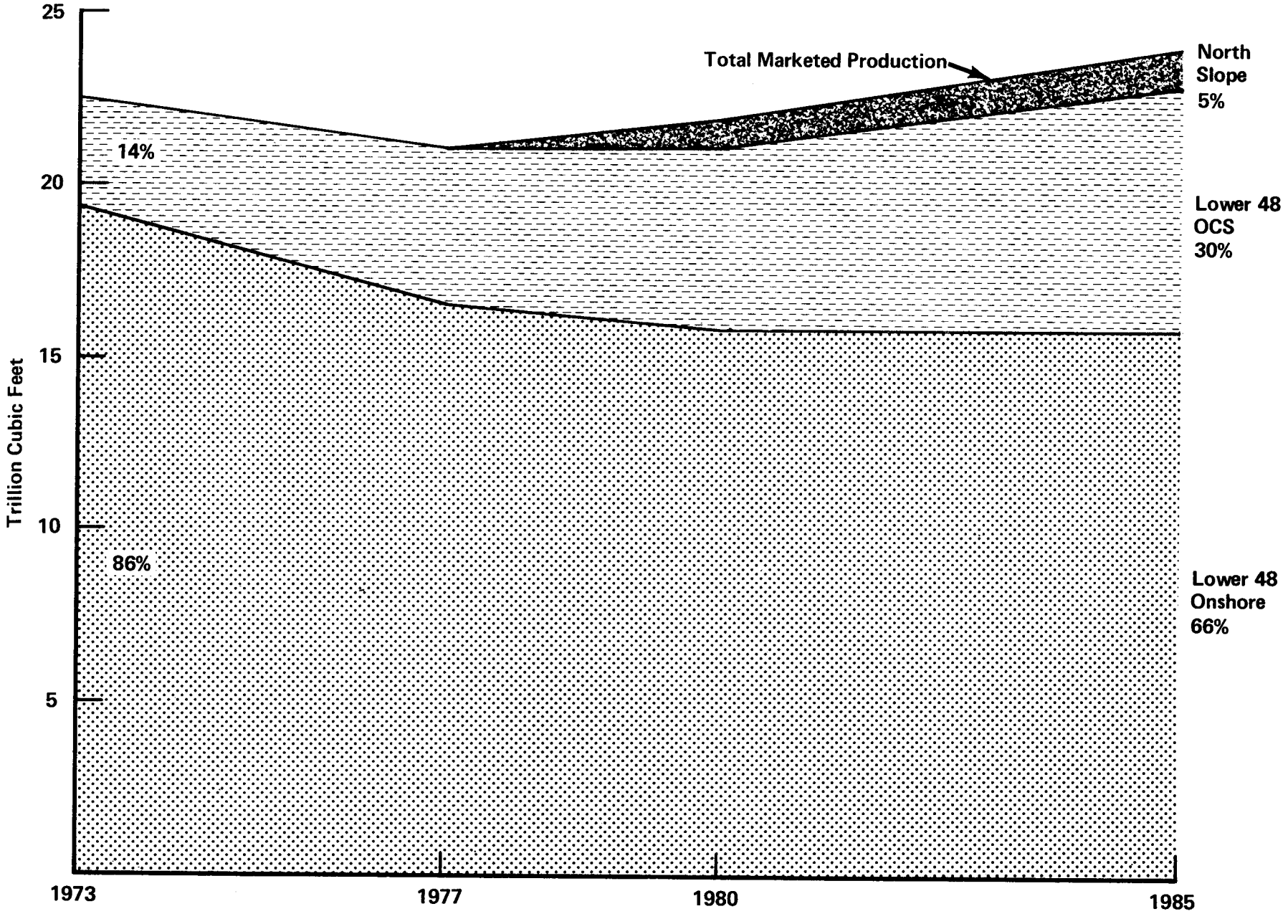
The lower 48 onshore States are expected to provide 66 percent of total marketed natural gas production in 1985 under business as usual, $11 oil.

**Projected U.S. Marketed Natural Gas Production[1]**
**(Trillions of Cubic Feet)**

| ITEM | 1973 | 1977 | | 1980 | | 1985 | |
|---|---|---|---|---|---|---|---|
| | | $7 | $11 | $7 | $11 | $7 | $11 |
| LOWER 48 ONSHORE | 19.4 | 16.2 | 16.6 | 15.2 | 15.8 | 14.6 | 15.8 |
| LOWER 48 OCS | 3.2 | 4.5 | 4.5 | 5.4 | 5.4 | 7.2 | 7.2 |
| NORTH SLOPE | 0 | 0 | 0 | .8 | .8 | 1.6 | 1.1 |
| TOTAL | 22.6 | 20.7 | 21.1 | 21.4 | 22.0 | 23.4 | 24.1 |

[1]Marketed natural gas refers to gross production less gas used for repressuring and quantities vented and flared.

# Projected U.S. Marketed Natural Gas Production




Source: Project Independence Report, 1974.

# U.S. Natural Gas Consumption

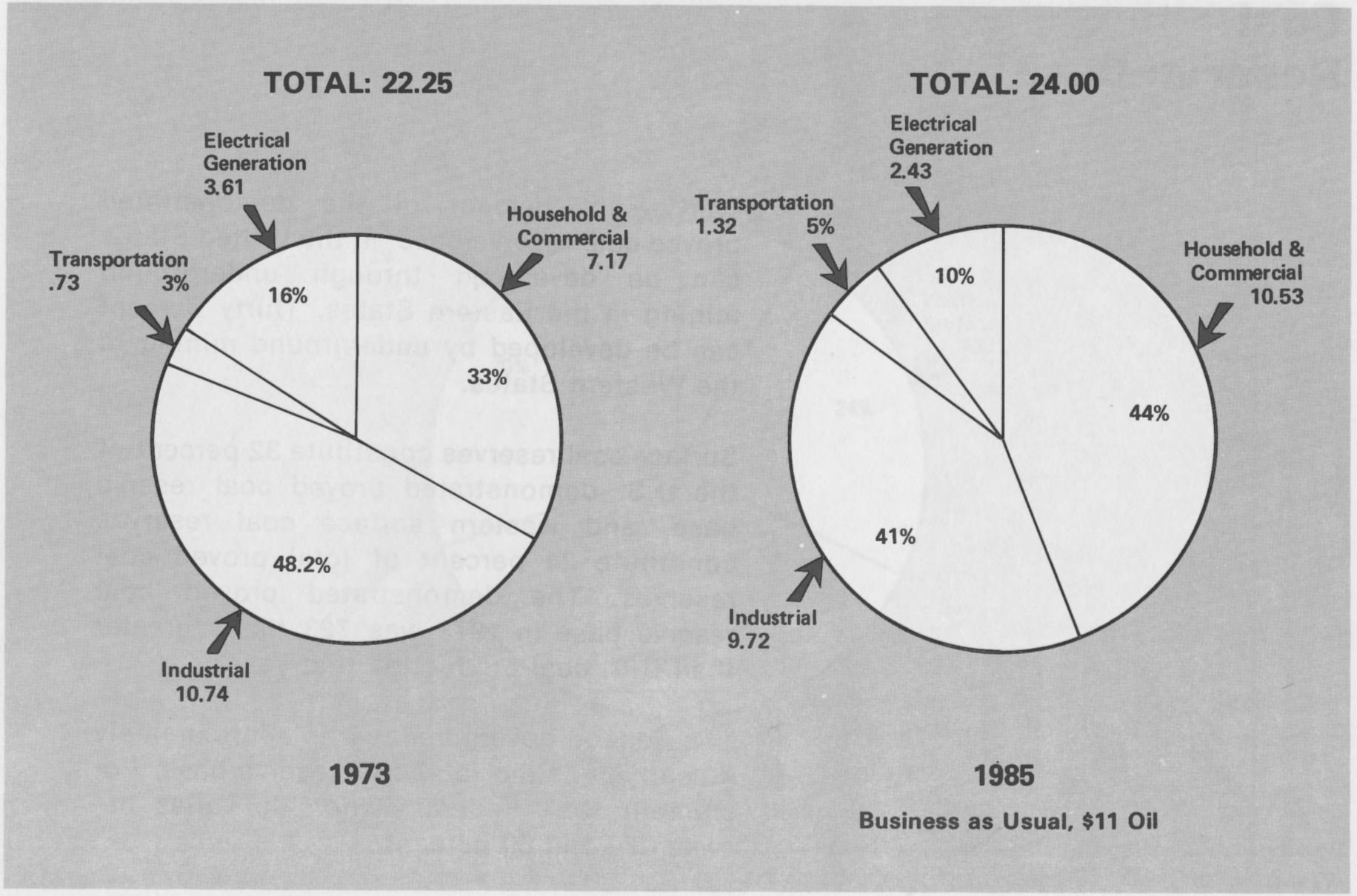
**[by Sector]**

Given business as usual, $11 oil, it is projected that natural gas consumption in the United States will increase at an annual rate of .6 percent during the 1973-85 period. Consumption in the household and commercial sector is projected to grow at an annual rate of 3.3 percent during this period.

Natural gas consumption in the industrial sector is projected to decline at an annual rate of .8 percent, and in electrical generation at a rate of 3.2 percent during the 1973-85 period.

# U.S. Natural Gas Consumption by Sector, 1973 and 1985

(Trillions of Cubic Feet)




Source: U.S. Bureau of Mines, 1974;
Project Independence Report, 1974.

# U.S. Demonstrated Coal Reserve Base[1]

Thirty-eight percent of the demonstrated proved coal reserve base[2] in the United States can be developed through underground mining in the Eastern States. Thirty percent can be developed by underground mining in the Western States.

Surface coal reserves constitute 32 percent of the U.S. demonstrated proved coal reserve base, and western surface coal reserves constitute 24 percent of total proved coal reserves. The demonstrated proved coal reserve base in 1973 was 723 times greater than U.S. coal production that year.

The Federal government owns approximately 40 percent of the total coal reserve base. For western coal, Federal ownership varies between 70 and 80 percent.

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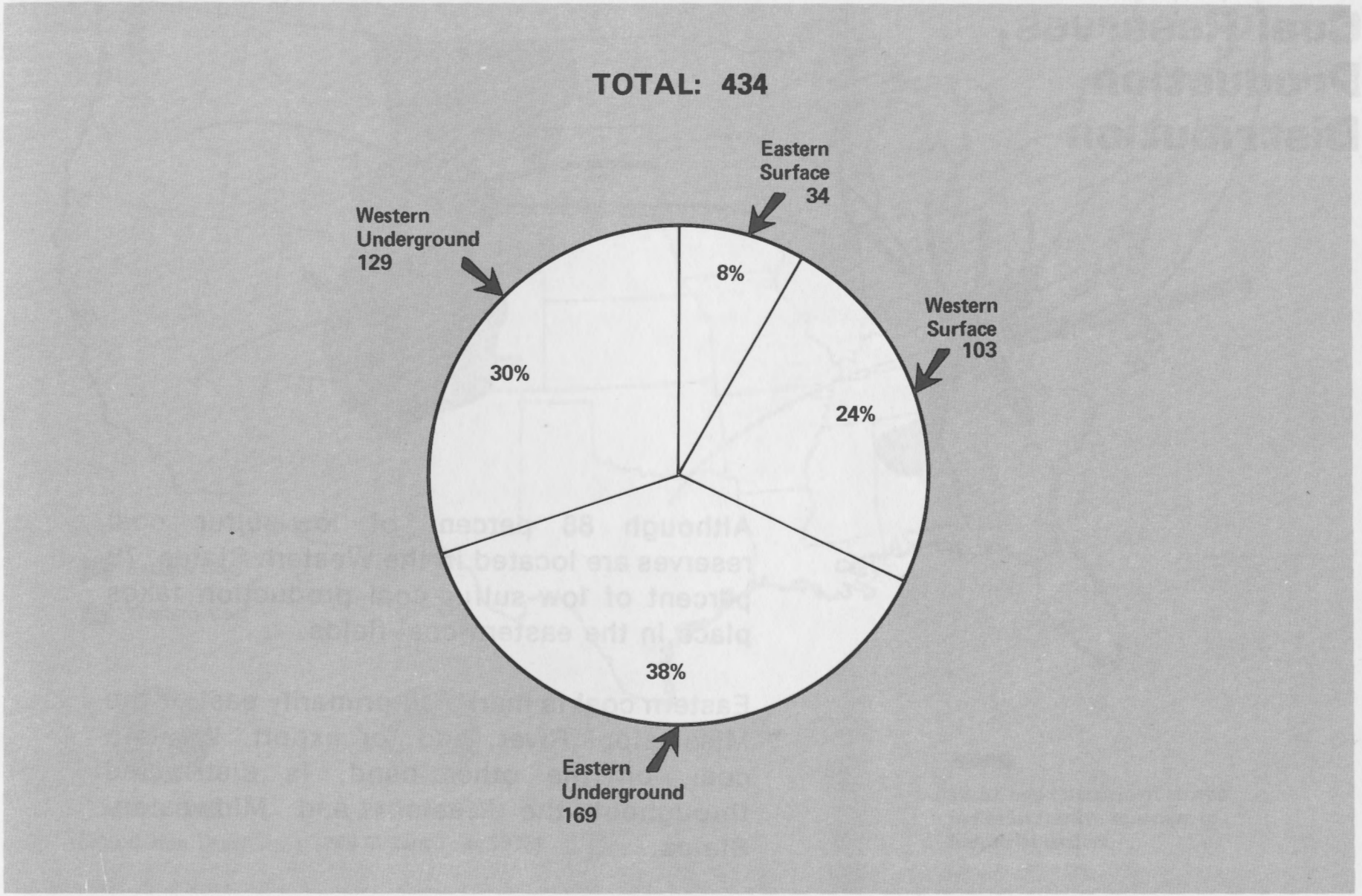
[1] Recoverability varies between 40 and 90 percent for individual deposits. Fifty percent or more of the overall coal reserve base in the United States is recoverable.

[2] See glossary for definition.

# U.S. Demonstrated Coal Reserve Base, January 1974

(Billions of Short Tons)



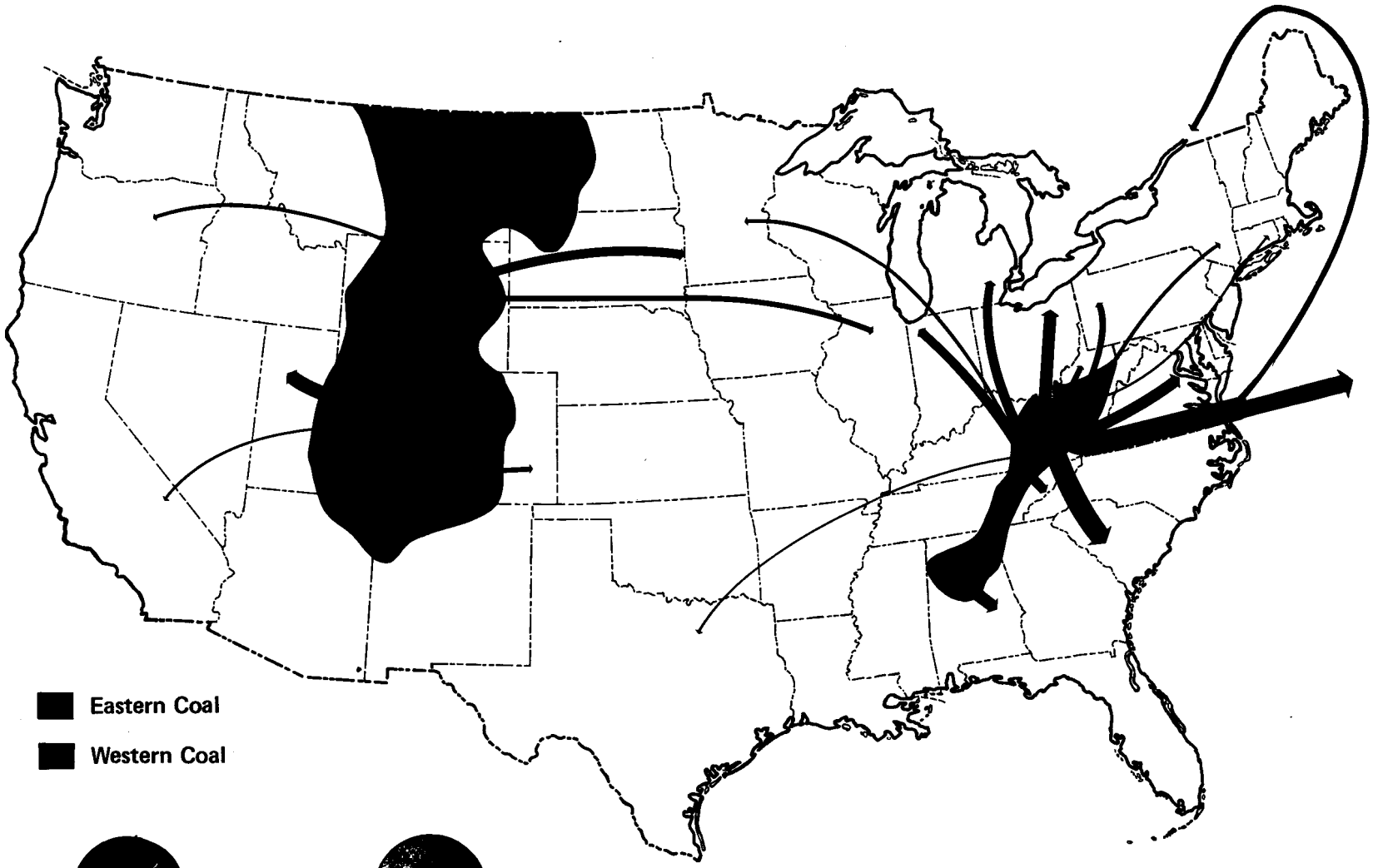

Source: U.S. Bureau of Mines, 1974.

# U.S. Low-Sulfur Coal Reserves, Production, Distribution

Although 88 percent of low-sulfur coal reserves are located in the Western States, 79 percent of low-sulfur coal production takes place in the eastern coal fields.

Eastern coal is marketed primarily east of the Mississippi River, and for export. Western coal, on the other hand, is distributed throughout the Western and Midwestern States.

# U.S. Low-Sulfur Coal Reserves, Production, Distribution, 1973



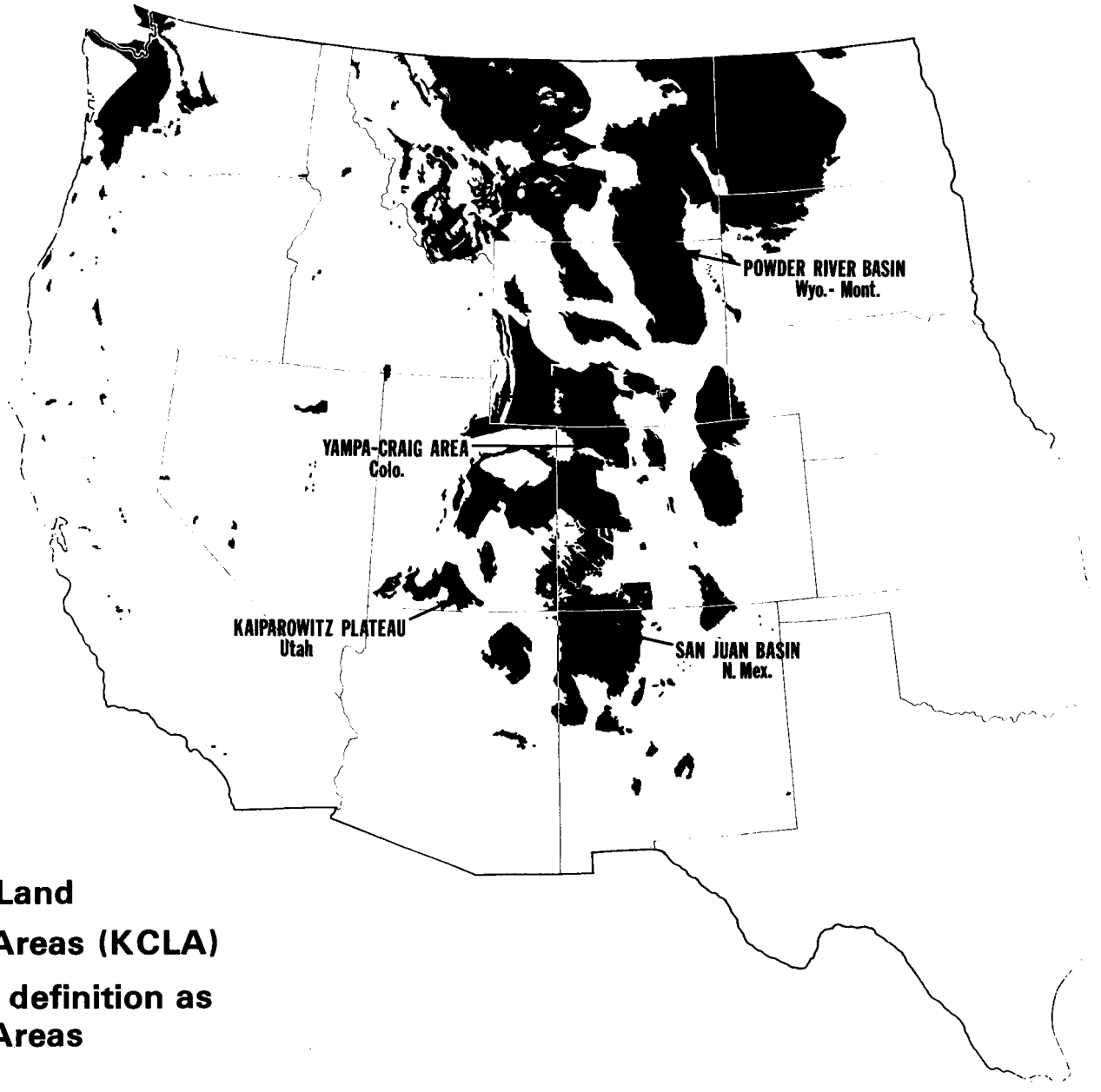

Source: U.S. Geological Survey, 1974.

# Known Federal Coal-Leasing Areas

The known Federal coal-leasing areas for competitive bidding will be located in the Western States, primarily in Utah, Colorado, New Mexico, Wyoming, Montana, and North Dakota.

The known coal leasing areas will include the Powder River Basin in Wyoming and Utah, the Yampa-Craig Area in Colorado, the Kaiparowitz Plateau in Utah, and the San Juan Basin in New Mexico.

# Known Federal Coal Leasing Areas for Competitive Bidding




Prospective Valuable Land

Known Coal Leasing Areas (KCLA)

* Areas under study for definition as Known Coal Leasing Areas

Source: U.S. Geological Survey, 1974.

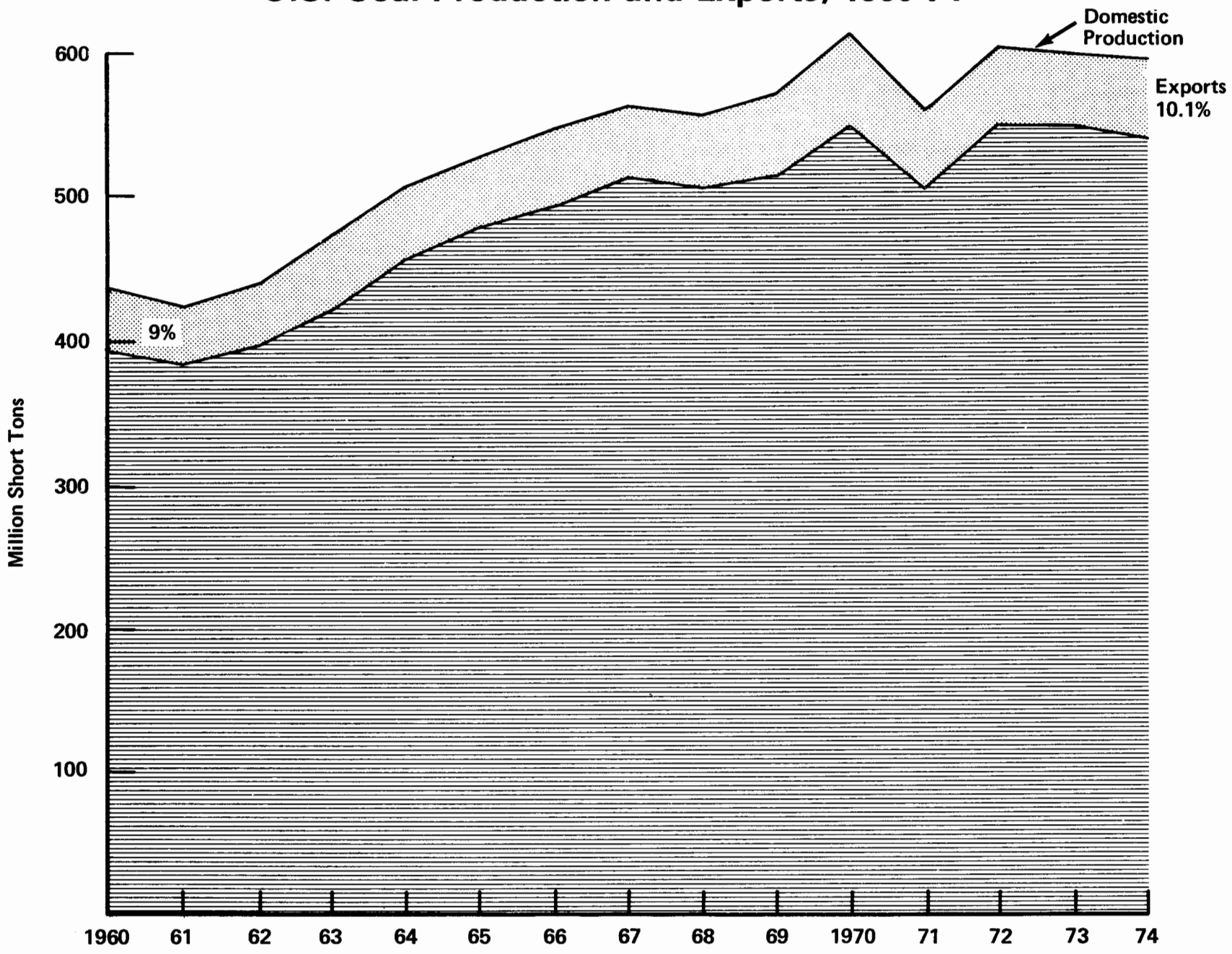
# U.S. Coal Production and Exports

From 1960 to 1974, domestic production of coal in the United States increased at an annual rate of 2.3 percent. During this same period, net coal exports increased approximately 3.4 percent annually.

**U.S. Coal Production and Exports, 1960-74**
**(Million Short Tons)**

| ITEM | YEAR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1960 | 1965 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| NET EXPORTS | 37.7 | 52.0 | 57.8 | 72.4 | 57.9 | 57.1 | 53.9 | 60.0 |
| DOMESTIC PRODUCTION | 434.3 | 527.0 | 571.0 | 612.7 | 560.9 | 602.5 | 598.6 | 596.0 |

# U.S. Coal Production and Exports, 1960-74




Source: U.S. Bureau of Mines, 1974.

# U.S. Coal Production

**[Federal and Indian Lands]**

In 1973, total coal production of 24 million short tons on Federal and Indian leases constituted 4 percent of total U.S. coal production. Cumulative production on Federal and Indian lands during the 1960-73 period was 146.6 million tons.

Coal production on Federal and Indian lands increased approximately 32 percent between 1973 and 1974.

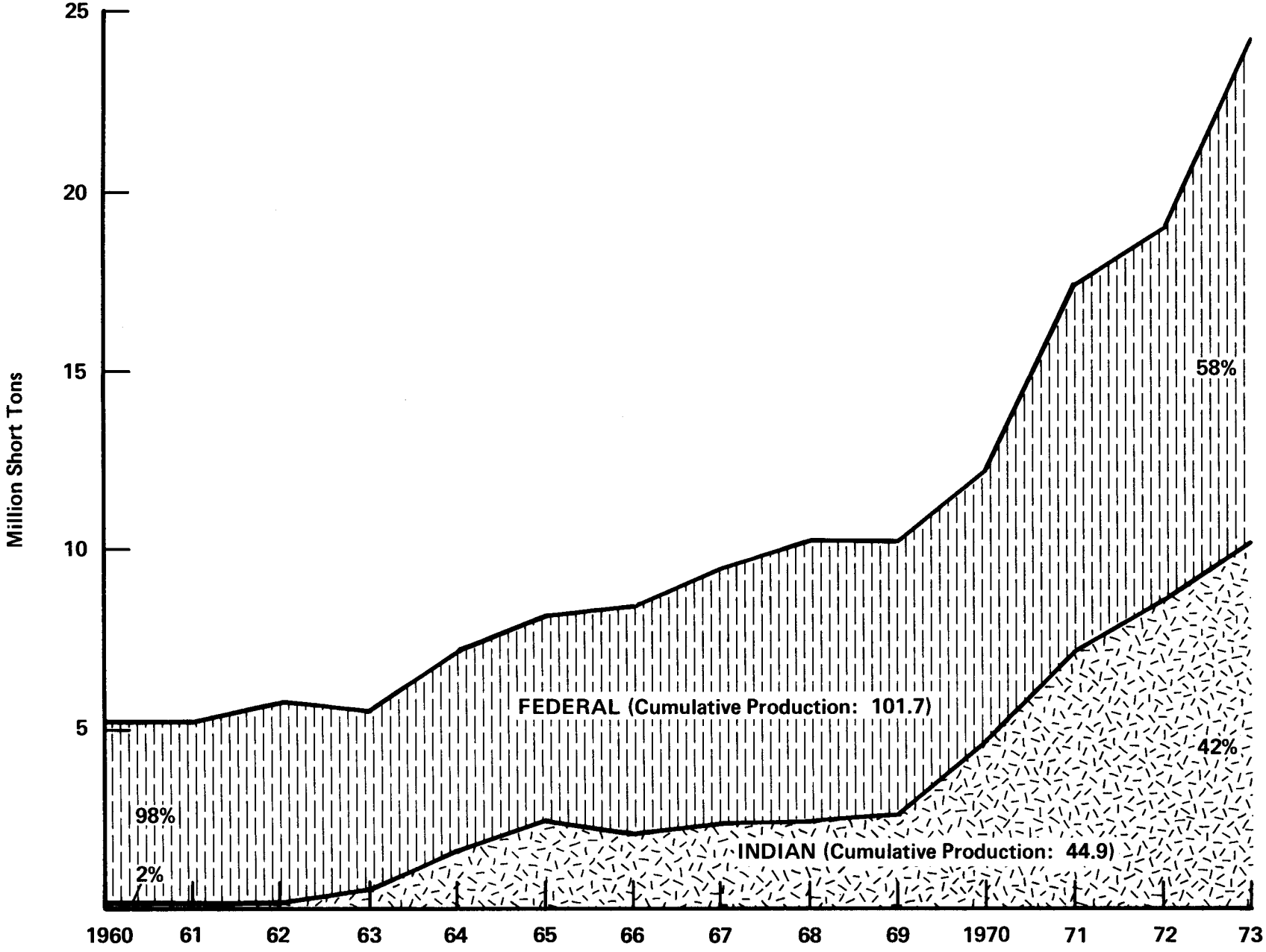
**U.S. Coal Production, Federal and Indian Lands, 1960-74**

**(Million Short Tons)**

| YEAR | FEDERAL LANDS | INDIAN LANDS | TOTAL |
|---|---|---|---|
| 1960 | 5.1 | .1 | 5.2 |
| 1961 | 5.1 | --- | 5.1 |
| 1962 | 5.8 | --- | 5.8 |
| 1963 | 5.0 | .5 | 5.5 |
| 1964 | 5.5 | 1.6 | 7.1 |
| 1965 | 5.7 | 2.5 | 8.2 |
| 1966 | 6.2 | 2.1 | 8.3 |
| 1967 | 7.1 | 2.4 | 9.5 |
| 1968 | 6.8 | 2.4 | 9.2 |
| 1969 | 7.5 | 2.6 | 10.1 |
| 1970 | 7.5 | 4.6 | 12.1 |
| 1971 | 10.1 | 7.2 | 17.3 |
| 1972 | 10.3 | 8.7 | 19.0 |
| 1973 | 14.0 | 10.2 | 24.2 |
| 1974[1] | 20.2 | 11.5 | 31.7 |

[1] Preliminary.

# U.S. Coal Production, Federal and Indian Lands




Source: U.S. Geological Survey, 1974.

# U.S. Potential Production of Coal on Federal Leases

Potential or unconstrained coal production on Federal leases in the United States is projected to increase at a 28-percent annual rate between 1973 and 1980, based on announced long-term contracts with no additional Federal leasing, and would increase at a 32-percent annual rate, based on announced long-term contracts with additional Federal leasing.

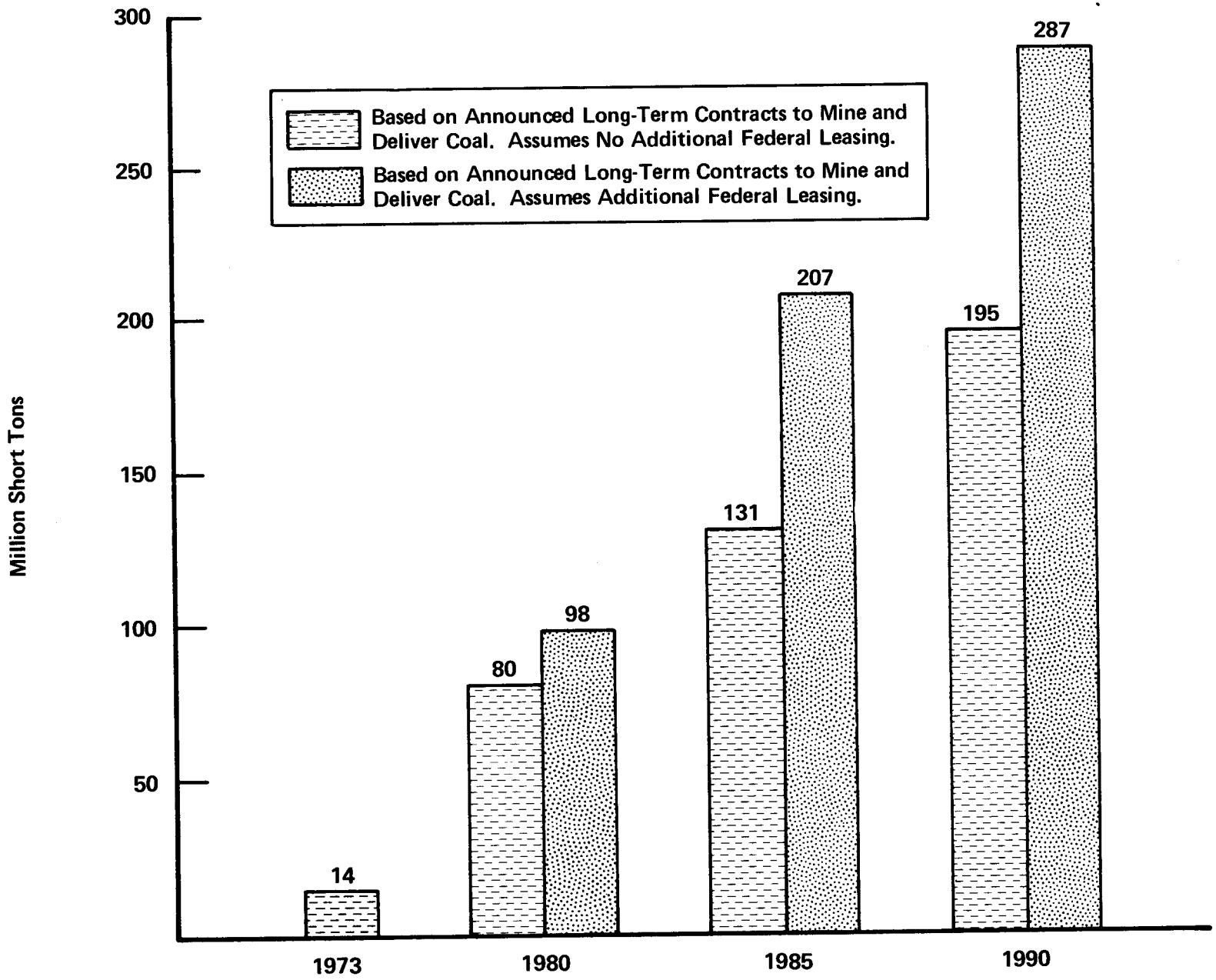
Potential coal production between 1973 and 1990 is projected to increase at a 17-percent annual rate, based on announced long-term contracts with no additional Federal leasing, and at a 19-percent annual rate, based on announced long-term contracts with additional Federal leasing.

**U.S. Potential Production of Coal on Federal Leases, 1973-90**

**(Millions of Short Tons)**

| ITEM | 1973 | 1975 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|
| ESTIMATES BASED PRIMARILY ON KNOWN COMMITMENTS FROM EXISTING LEASES AND NO ADDITIONAL FEDERAL LEASING | 14 | 41.3 | 80 | 131 | 195 |
| PRODUCTION BASED ON ABOVE PLUS ADDITIONAL FEDERAL LEASING IN RESPONSE TO APPLICATIONS | | 41.3 | 98 | 207 | 287 |

# U.S. Potential Production of Coal on Federal Leases, 1973-90




Source: Interagency Coal Task Force Report, U.S. Department of the Interior, 1974.

# U.S. Coal Consumption

**[by Sector]**

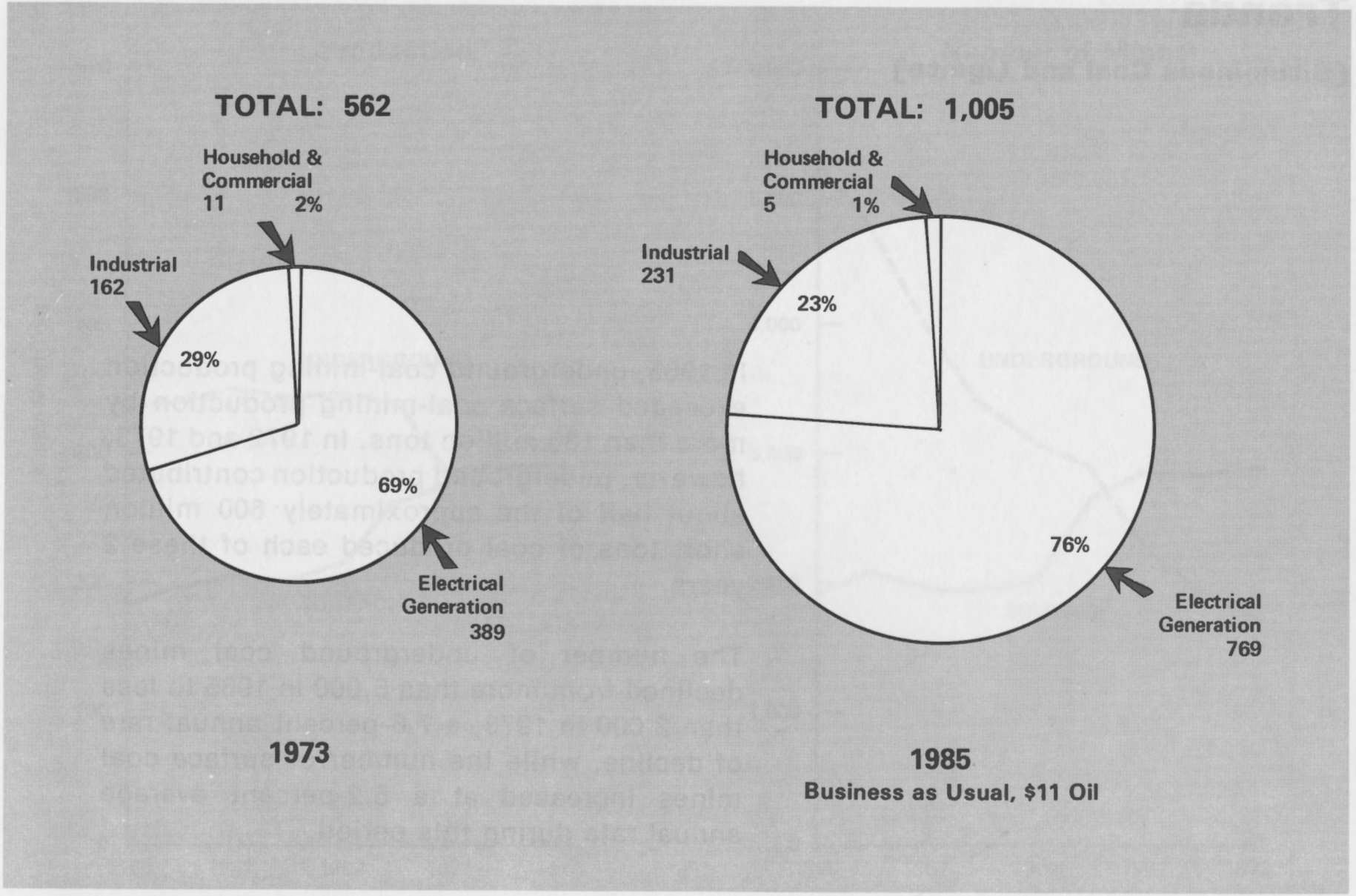
Under business as usual, $11 oil, U.S. coal consumption is projected to increase at an annual rate of 5 percent during the 1973-85 period.

Coal consumption for electrical generation is projected to increase at an annual rate of 5.8 percent during this period, while industrial consumption would increase at an annual rate of 3 percent.

In 1985, coal capacity is projected to be 35 percent of the total capacity of the electric utility industry.

# U.S. Coal Consumption, by Sector, 1973 and 1985

(Million Short Tons)




Source: U.S. Bureau of Mines, 1974;
Project Independence Report, 1974.

# U.S. Coal Trends

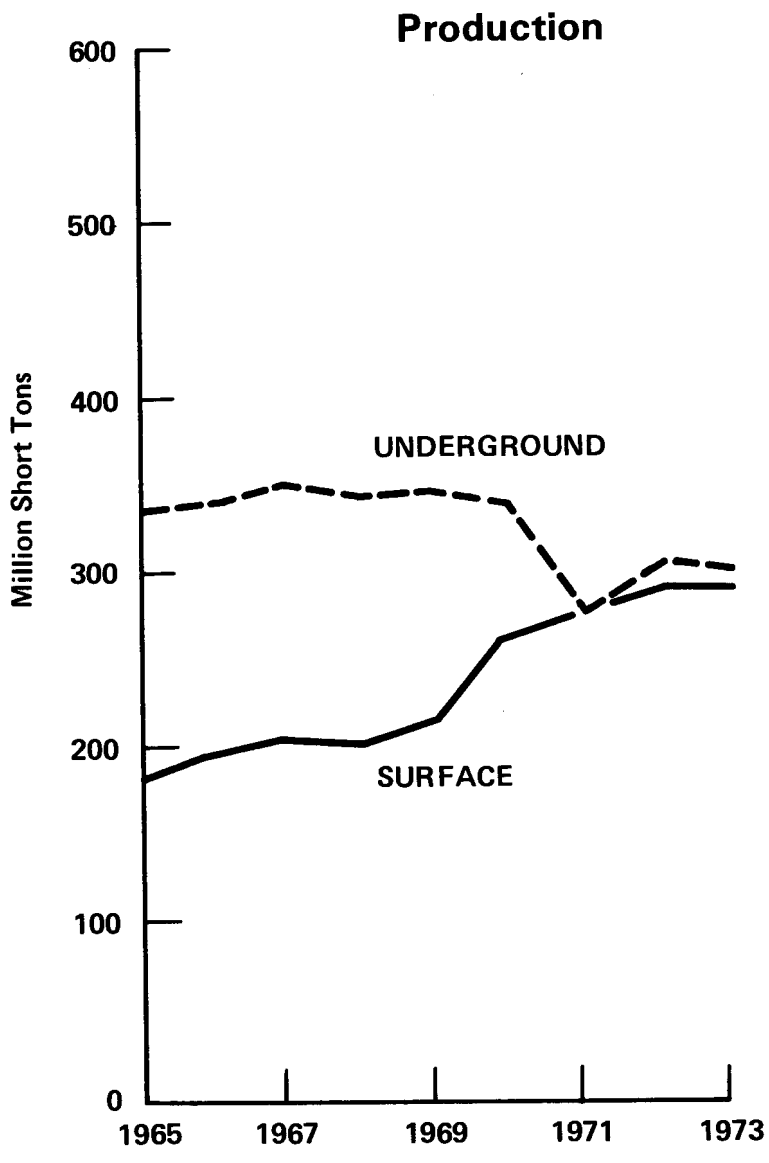
**[Bituminous Coal and Lignite]**

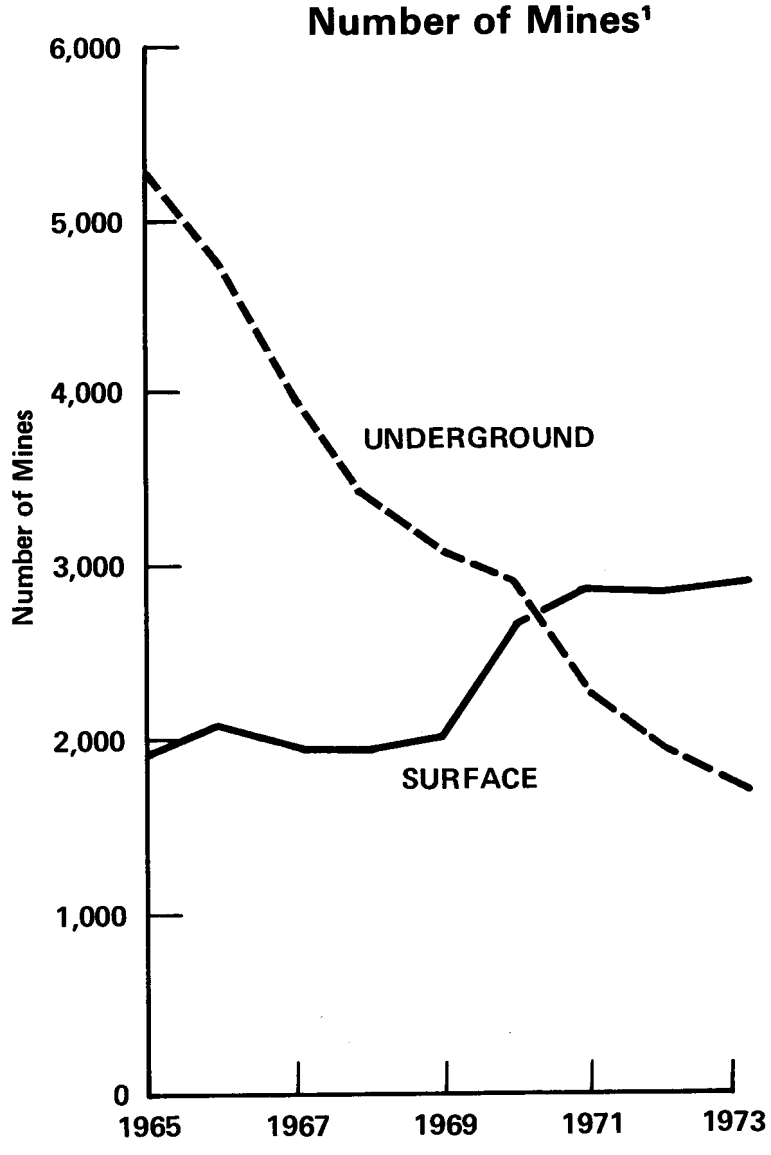
In 1965, underground coal-mining production exceeded surface coal-mining production by more than 130 million tons. In 1972 and 1973, however, underground production contributed about half of the approximately 600 million short tons of coal produced each of these 2 years.

The number of underground coal mines declined from more than 5,000 in 1965 to less than 2,000 in 1973, a 7.6-percent annual rate of decline, while the number of surface coal mines increased at a 5.2-percent average annual rate during this period.

# U.S. Coal Trends, 1965-73

(Bituminous Coal and Lignite)




[1] All coal mines that produced 1,000 tons of coal during the year.

Source: U.S. Bureau of Mines, 1974.

# U.S. Coal Transportation Costs

**[By Mode]**

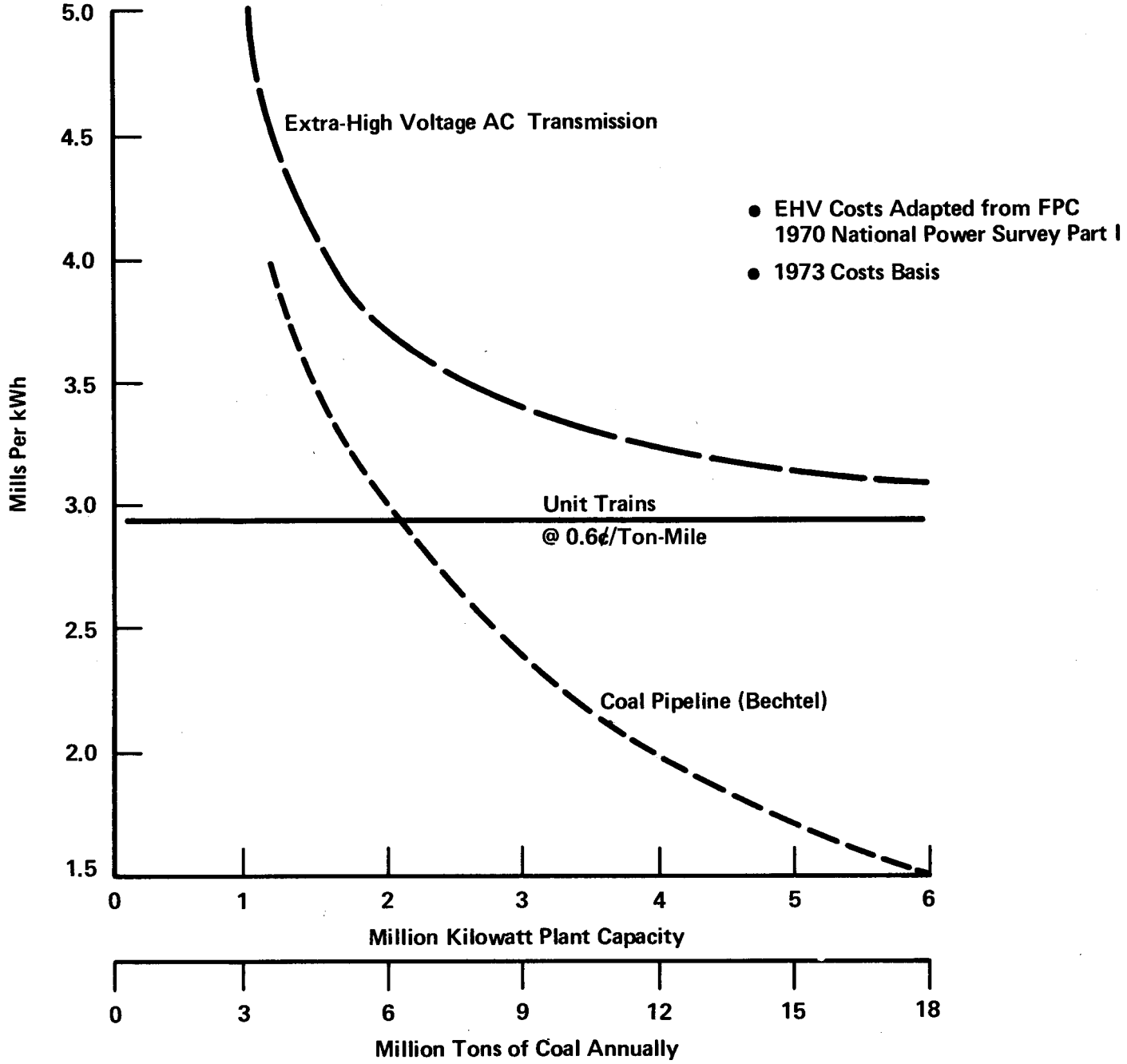
Over a given transport distance, variations in tonnages hauled do not affect average costs for moving coal by unit trains. Average costs do decline significantly, however, with increases in the quantity of coal transported by slurry pipelines. For coal movements in excess of 6 million tons annually, the slurry pipeline is the most economic transport mode.

Coal transportation costs, in relation to Btu content are lower for high-Btu coal than for low-Btu coal.

Railroad transport may have to be supplemented by coal slurry pipeline or by gas and liquid pipelines and extra-high-voltage AC transmission to effectively move the increased coal produced by western mines.

# U.S. Coal Transportation Costs, By Mode

(For a 1,000-Mile Transport Distance)




Source: U.S. Energy Prospects: An Engineering Viewpoint, National Academy of Engineering, 1974, page 38.

# Projected Production of Synthetic Fuels from Coal

Under business as usual, $11 oil, potential production of high-Btu pipeline gas from coal is projected to increase at an annual rate of 29 percent between 1985 and 1990 and to reach a production level of 1,300 billion cubic feet a year in 1990.

Given accelerated supply, $11 oil, potential production of high-Btu pipeline gas is estimated to increase at an annual rate of 17 percent between 1985 and 1990, and to reach a production level of 2,800 billion cubic feet in 1990.

Under accelerated supply, synthetic high-Btu gas production in 1985 would constitute approximately 3 percent of total gas consumption, and synthetic liquid production would be 2 to 3 percent of petroleum consumption.

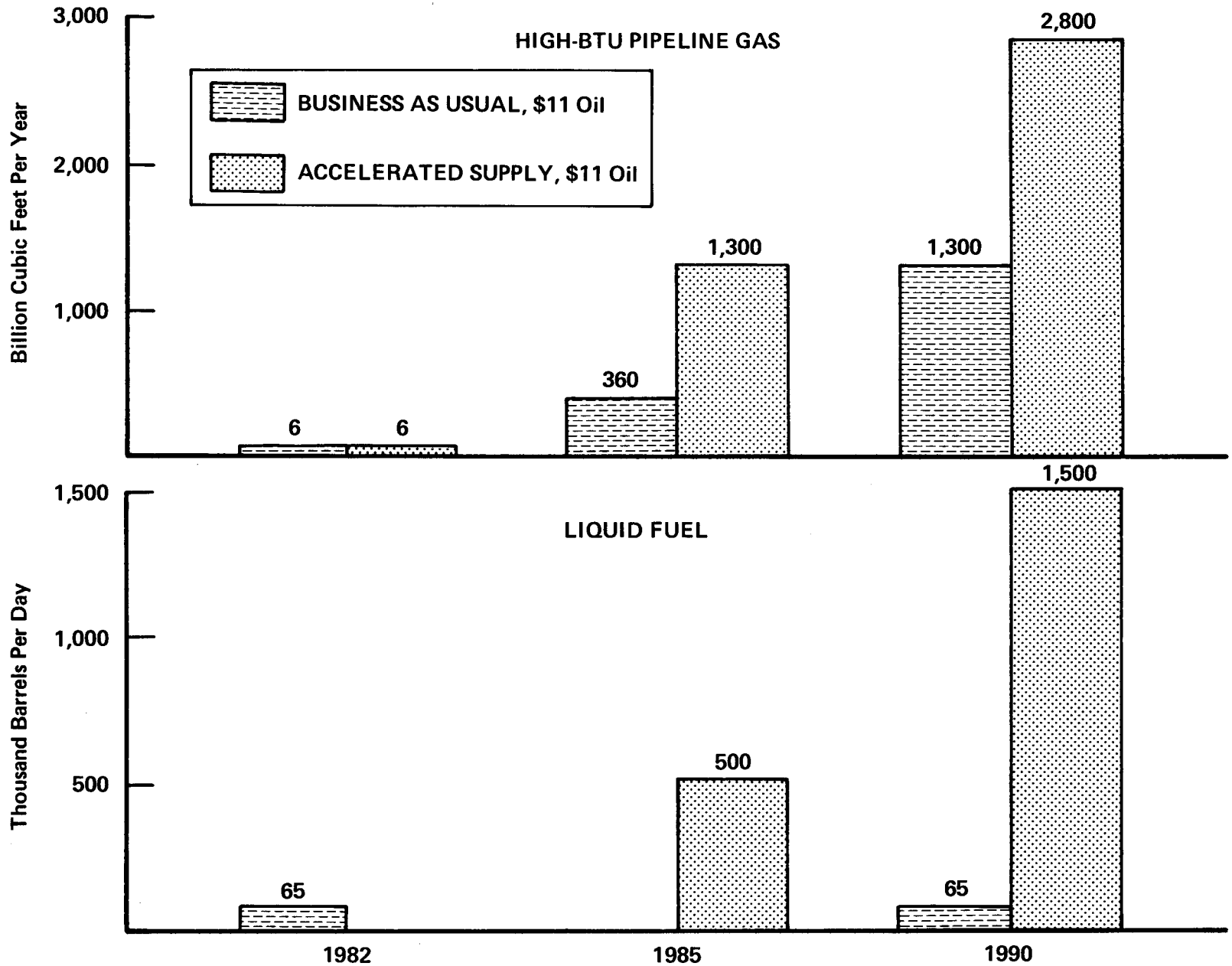
**Projected Production of Synthetic Fuels from Coal**

| FUEL | TOTAL OUTPUT | | NUMBER OF PLANTS | |
|---|---|---|---|---|
| | BAU | AS | BAU | AS |
| HIGH-BTU PIPELINE GAS[1] (Billion $Ft^3$/Year): | | | | |
| 1980 | 6 | 6 | 1 | 1 |
| 1985 | 360 | 1,300 | 7 | 20 |
| 1990 | 1,300 | 2,800 | 17 | 34 |
| LIQUID FUEL[1] (Thousand Bbl/Day): | | | | |
| 1982 | --- | 65 | --- | 1 |
| 1985 | --- | 500 | --- | 8 |
| 1990 | 65 | 1,500 | 1 | 18 |

[1] Given a crude oil price of $11/barrel.

BAU = business as usual;
AS = accelerated supply.

# Projected Production of Synthetic Fuels from Coal




Source: Interagency Task Force Report on Synthetic Fuels from Coal, Federal Energy Administration, September 1974.

# Costs of Synthetic Fuels from Coal

Total plant investment and product costs for alternative synthetic fuel products using U.S. eastern or western coal are presented in the following table.

Plant investment costs and costs of alternative synthetic fuel products from coal should be related to the differential plant outputs and heat values.

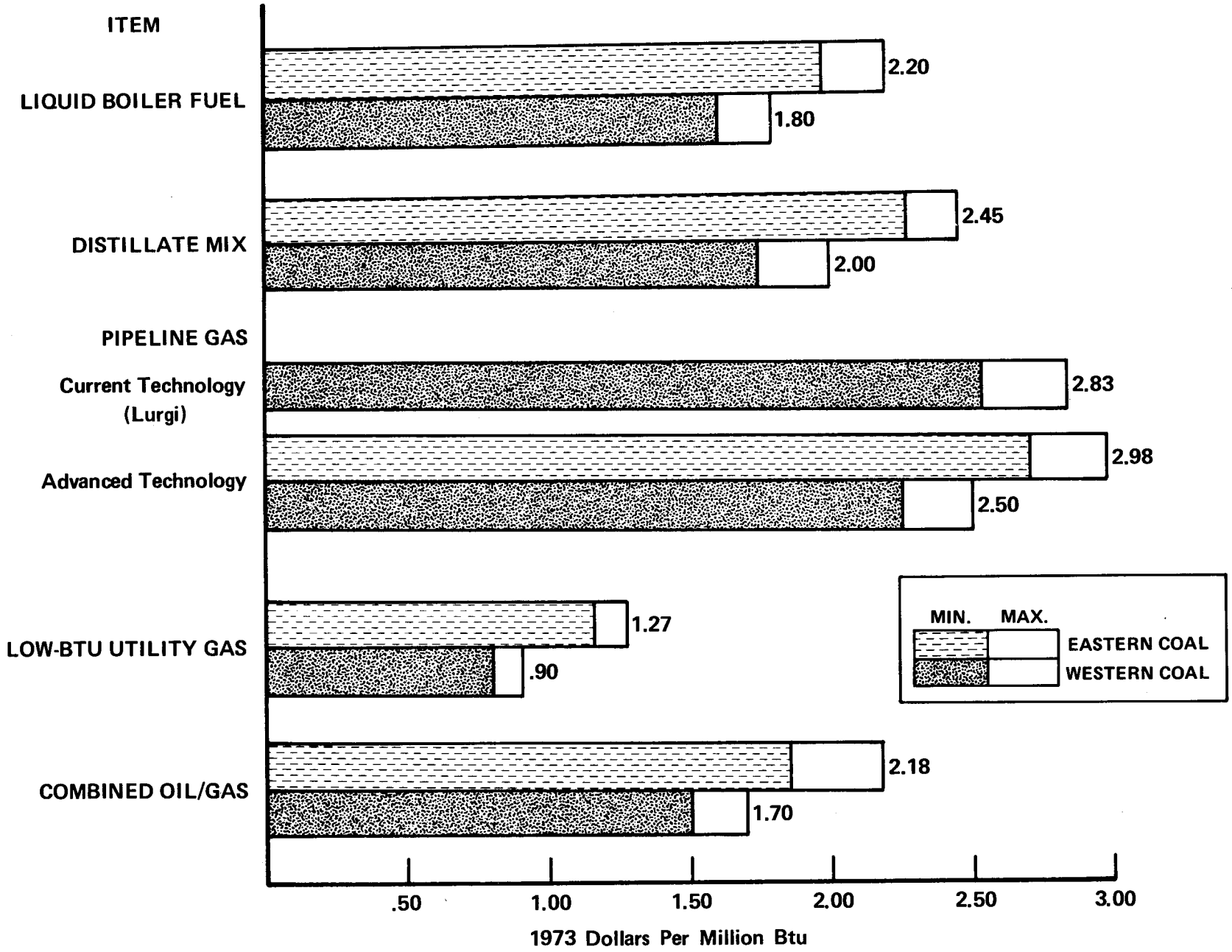
## Costs of Synthetic Fuels From Coal[1], 1973

| PRODUCT | HEAT VALUE | | PLANT OUTPUT | | TOTAL PLANT INVESTMENT (Millions of Dollars) | | PRODUCT COSTS[2] (Dollars Per Million Btu) | |
|---|---|---|---|---|---|---|---|---|
| | Btu per cf | Btu per Bbl | cf/day | Bbls/day | EASTERN COAL | WESTERN COAL | EASTERN COAL | WESTERN COAL |
| LIQUID BOILER FUEL | | 6,400,000 | | 65,000 | 427-540 | 450-590 | 1.98-2.20 | 1.60-1.80 |
| DISTILLATE MIX | | 6,400,000 | | 65,000 | 595-750 | 620-815 | 2.26-2.45 | 1.75-2.00 |
| PIPELINE GAS: | | | | | | | | |
| CURRENT TECHNOLOGY (Lurgi) | 930 | | $250 \times 10^6$ | | --- | 475-625 | --- | 2.53-2.83 |
| ADVANCED TECHNOLOGY | 930 | | $250 \times 10^6$ | | 380-480 | 380-500 | 2.70-2.98 | 2.25-2.50 |
| LOW-BTU UTILITY GAS | 130 | | $1700 \times 10^6$ | | 70-90 | 70-95 | 1.15-1.27 | .80-.90 |
| COMBINED OIL/GAS | 930 | 6,400,000 | $225 \times 10^6$ | 40,000 | 450-600 | 475-665 | 1.85-2.18 | 1.50-1.70 |

[1] Synthetic liquids are desulfurized

[2] Based on a 15 percent discounted cash flow.

# Costs of Synthetic Fuels from Coal, 1973




Source: Interagency Task Force Report on Synthetic Fuels from Coal, Federal Energy Administration, September 1974.

# Land Use, Bituminous Coal Industry

Ninety-one percent of the land utilized by the bituminous coal industry during the 1930-71 period resulted primarily from surface coal mining.

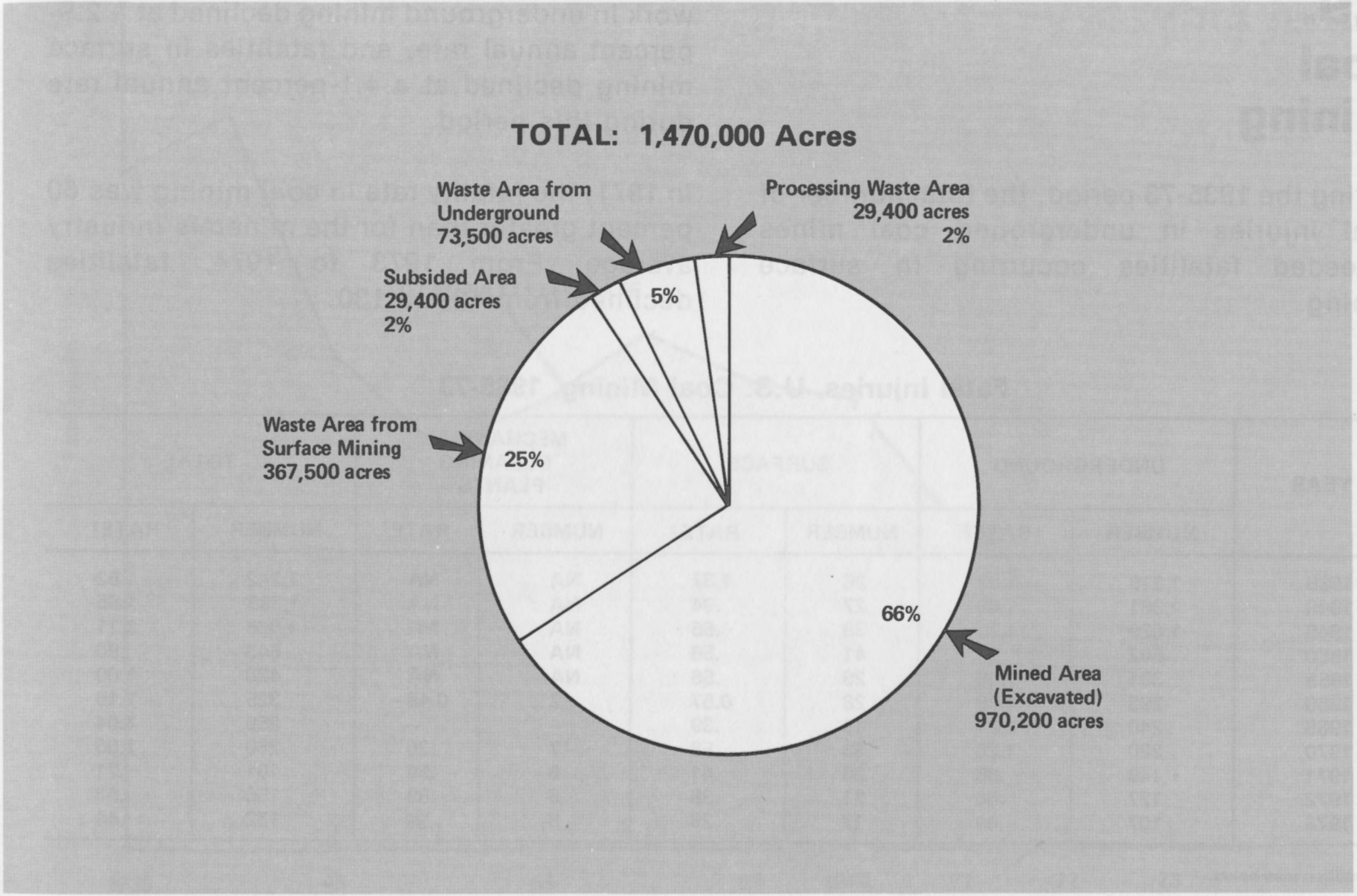
From 1930 to 1971, the bituminous coal industry reclaimed 1 million acres, or 68 percent of 1,470,000 acres used by the industry.

In 1971, the industry reclaimed 21,400 acres more than the 73,200 acres it used.

**Land Utilized and Reclaimed by the Bituminous Coal Industry, 1930-1971**
**(Acres)**

| | |
|---|---|
| LAND UTILIZED: | |
| 1930-71 | 1,470,000 |
| 1971 | 73,200 |
| LAND RECLAIMED: | |
| 1930-71 | 1,000,000 |
| 1971 | 94,600 |
| PERCENT RECLAIMED, 1930-71 | 68 |

# Land Use, Bituminous Coal Mining, 1930-71




Source: IC 8642, Land Utilization and Reclamation in the Mining Industry, 1930-71, U.S. Bureau of Mines, 1974.

# Fatal Injuries, U.S. Coal Mining

During the 1935-73 period, the total number of fatal injuries in underground coal mines exceeded fatalities occurring in surface mining.

Coal mine fatalities per million man-hours of work in underground mining declined at a 2.9-percent annual rate, and fatalities in surface mining declined at a 4.1-percent annual rate during this period.

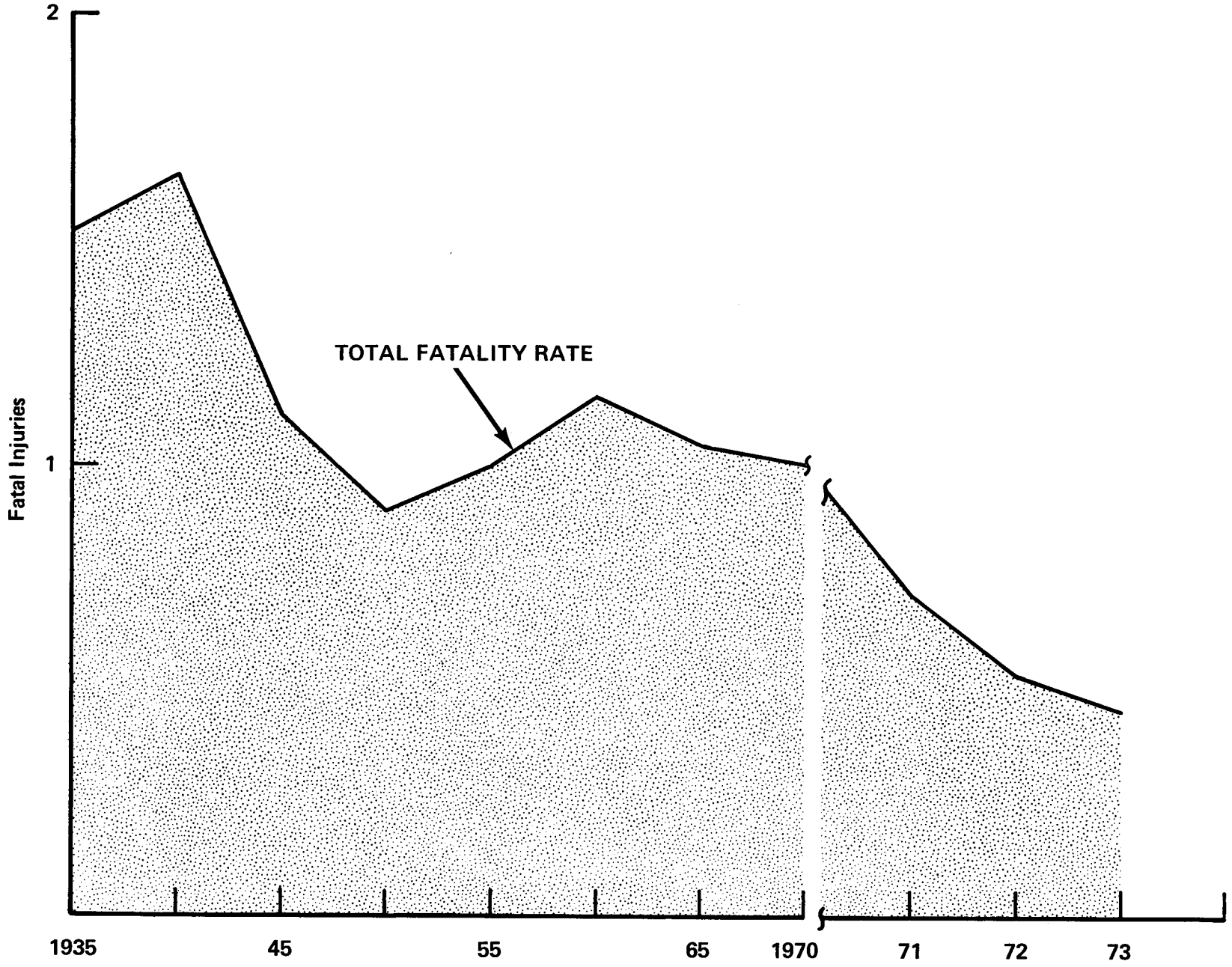
In 1971, the fatality rate in coal mining was 60 percent greater than for the minerals industry average. From 1973 to 1974, fatalities declined from 132 to 130.

**Fatal Injuries, U.S. Coal Mining, 1935-73**

| YEAR | UNDERGROUND | | SURFACE | | MECHANICAL CLEANING PLANTS | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | NUMBER | RATE[1] | NUMBER | RATE[1] | NUMBER | RATE[1] | NUMBER | RATE[1] |
| 1935 | 1,216 | 1.52 | 26 | 1.37 | NA | NA | 1,242 | 1.52 |
| 1940 | 1,361 | 1.68 | 27 | .94 | NA | NA | 1,388 | 1.65 |
| 1945 | 1,029 | 1.16 | 39 | .55 | NA | NA | 1,068 | 1.11 |
| 1950 | 602 | .94 | 41 | .56 | NA | NA | 643 | .90 |
| 1955 | 391 | 1.06 | 29 | .56 | NA | NA | 420 | 1.00 |
| 1960 | 295 | 1.29 | 28 | 0.57 | 2 | 0.48 | 325 | 1.15 |
| 1965 | 240 | 1.21 | 19 | .39 | — | — | 259 | 1.04 |
| 1970 | 220 | 1.20 | 33 | .58 | 7 | .36 | 260 | 1.00 |
| 1971 | 149 | .86 | 26 | .41 | 6 | .34 | 181 | .71 |
| 1972 | 127 | .60 | 21 | .35 | 8 | .39 | 156 | .53 |
| 1973 | 107 | .49 | 17 | .28 | 8 | .38 | 132 | .44 |

[1]Per million man-hours.

# Fatal Injuries, U.S. Coal Mining, 1935-73




Source: U.S. Department of the Interior, 1975; Statistical Abstract of the U.S., 1973.

# Nonfatal Injuries, U.S. Coal Mining

During the 1935-73 period, nonfatal injury rates occurring in underground coal production exceeded those occurring in surface mining and in mechanical cleaning plants.

During this period, underground nonfatality rates declined at a 1.2-percent annual rate, and surface mining at a 3.2-percent annual rate.

Mechanical-cleaning-plant injury rates have declined at a 5.2-percent annual rate since 1960.

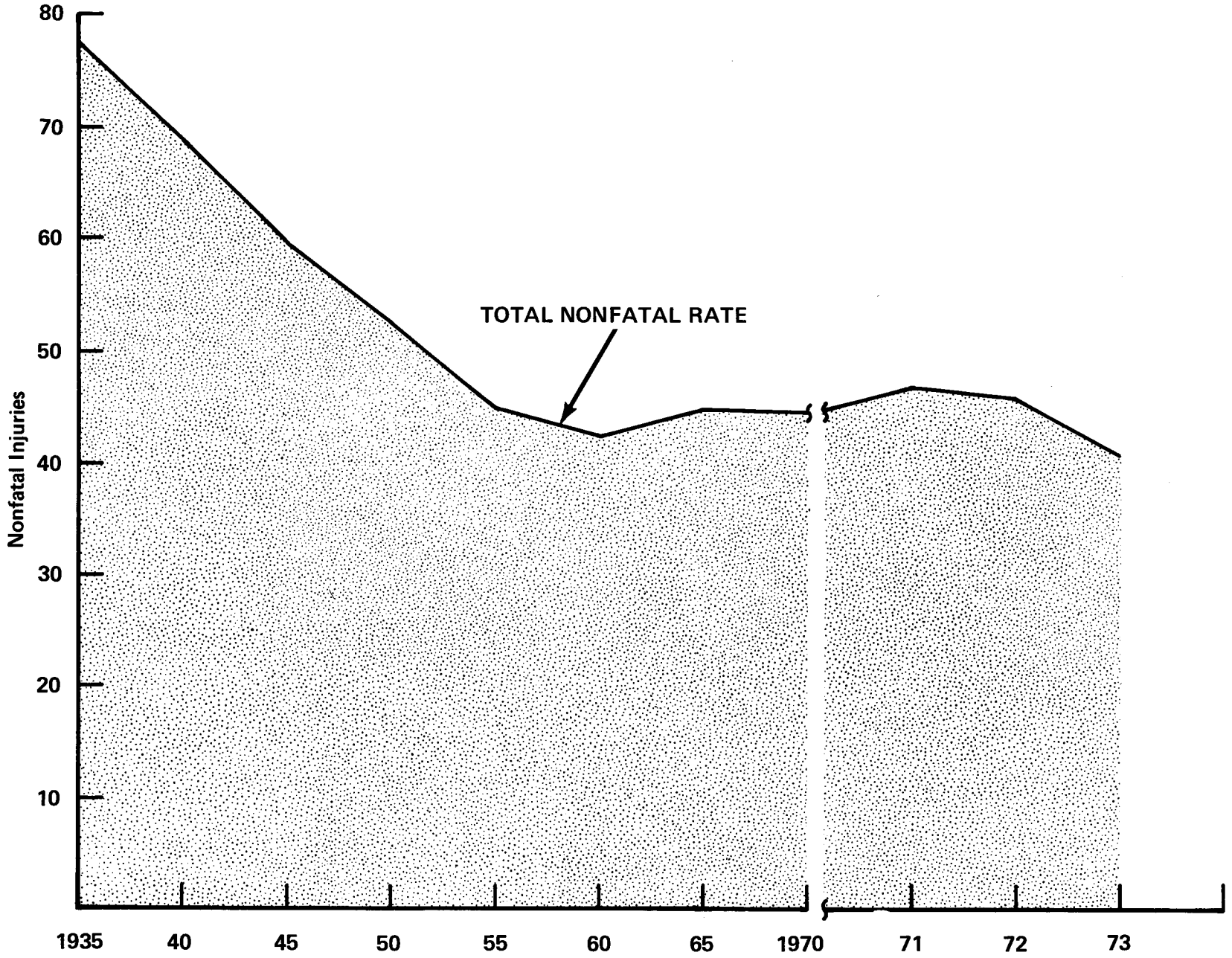
The frequency rate of nonfatal injuries in coal mining were approximately 200 percent greater than the manufacturing average in 1970.

**Nonfatal Injuries in U.S. Coal Mining, 1935-73**

| YEAR | UNDERGROUND | | SURFACE | | MECHANICAL CLEANING PLANTS | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | NUMBER | RATE[1] | NUMBER | RATE[1] | NUMBER | RATE[1] | NUMBER | RATE[1] |
| 1935 | 62,121 | 77.63 | 1,305 | 68.86 | NA | NA | 63,426 | 77.43 |
| 1940 | 56,257 | 69.32 | 1,519 | 52.67 | NA | NA | 57,776 | 68.75 |
| 1945 | 54,278 | 61.17 | 2,839 | 39.83 | NA | NA | 57,117 | 59.58 |
| 1950 | 34,986 | 54.77 | 2,278 | 31.39 | NA | NA | 37,264 | 52.38 |
| 1955 | 17,699 | 48.10 | 1,186 | 23.07 | NA | NA | 18,885 | 45.03 |
| 1960 | 10,520 | 46.09 | 1,217 | 24.81 | 165 | 39.19 | 11,902 | 42.28 |
| 1965 | 9,705 | 49.09 | 1,271 | 26.39 | 162 | 51.62 | 11,138 | 44.73 |
| 1970 | 9,531 | 51.79 | 1,458 | 25.60 | 563 | 29.34 | 11,552 | 44.40 |
| 1971 | 9,756 | 56.40 | 1,700 | 26.81 | 460 | 25.96 | 11,916 | 46.89 |
| 1972 | 10,790 | 56.84 | 1,155 | 20.41 | 387 | 17.80 | 12,332 | 45.67 |
| 1973 | 9,466 | 49.04 | 1,161 | 19.80 | 440 | 19.49 | 11,067 | 40.42 |

[1] Per million man-hours.

# Nonfatal Injuries, U.S. Coal Mining, 1935-73




Source: U.S. Department of the Interior, 1975; Statistical Abstract of the U.S., 1973.

# Projected U.S. Nuclear Power Plant Capacity

Significant nuclear power plant capacity increases are projected from 1973 to 1990. Capacity is estimated to increase at an annual rate of 21.4 percent between 1973 and 1985 under business as usual, $7 oil, and 23 percent under accelerated development, $11 oil.

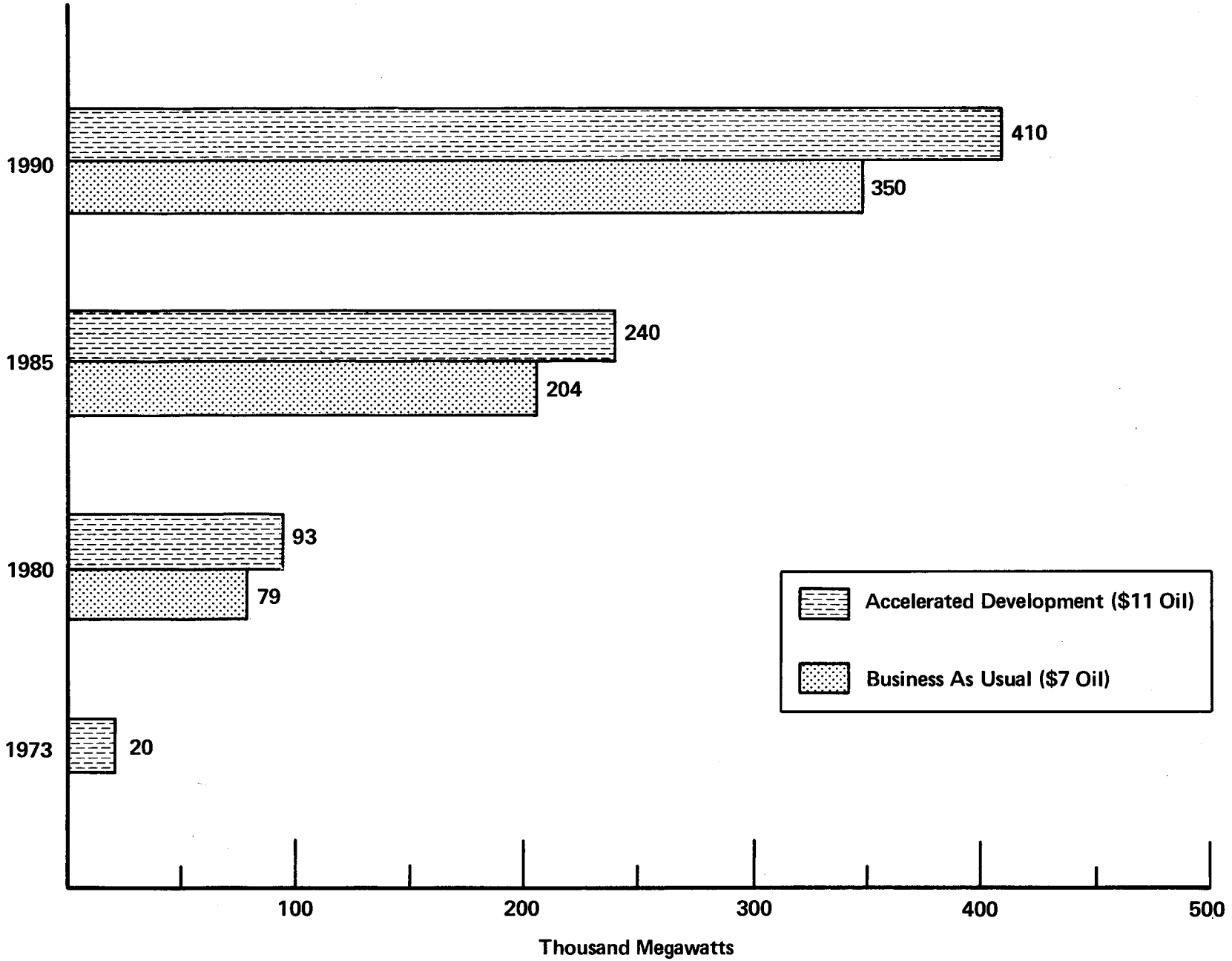
Recently, nuclear capacity projections have been revised. The most recent Atomic Energy Commission 1985 projection is 189.5 thousand megawatts.[1] This projection would represent a 20.6-percent annual increase in capacity.

In 1985, nuclear power plant capacity is expected to represent 22 percent of total capacity, given business as usual, $11 oil.

Annual rate increases for the 1985-90 period of 11.4 percent and 11.3 percent are projected for the business as usual, $7 oil, and accelerated development, $11 oil strategies.

[1] 1 megawatt = 1,000 kilowatts.

# Projected U.S. Nuclear Power Plant Capacity, 1973-90




Source: Project Independence Report, 1974, page 113; Nuclear Power Growth, 1974-2000, Atomic Energy Commission, 1974, page 46; The Nuclear Industry, 1974, Atomic Energy Commission, 1975, page 7; 1985-90 extrapolated.

# Projected U.S. Uranium Oxide Requirements

Uranium oxide requirements are projected to increase thirteenfold given an accelerated supply policy during the 1973-90 period.

Recent slippages in the development of nuclear plant capacity recently reported by the Atomic Energy Commission (AEC) in *The Nuclear Industry, 1974*, may reduce projected uranium oxide requirements.

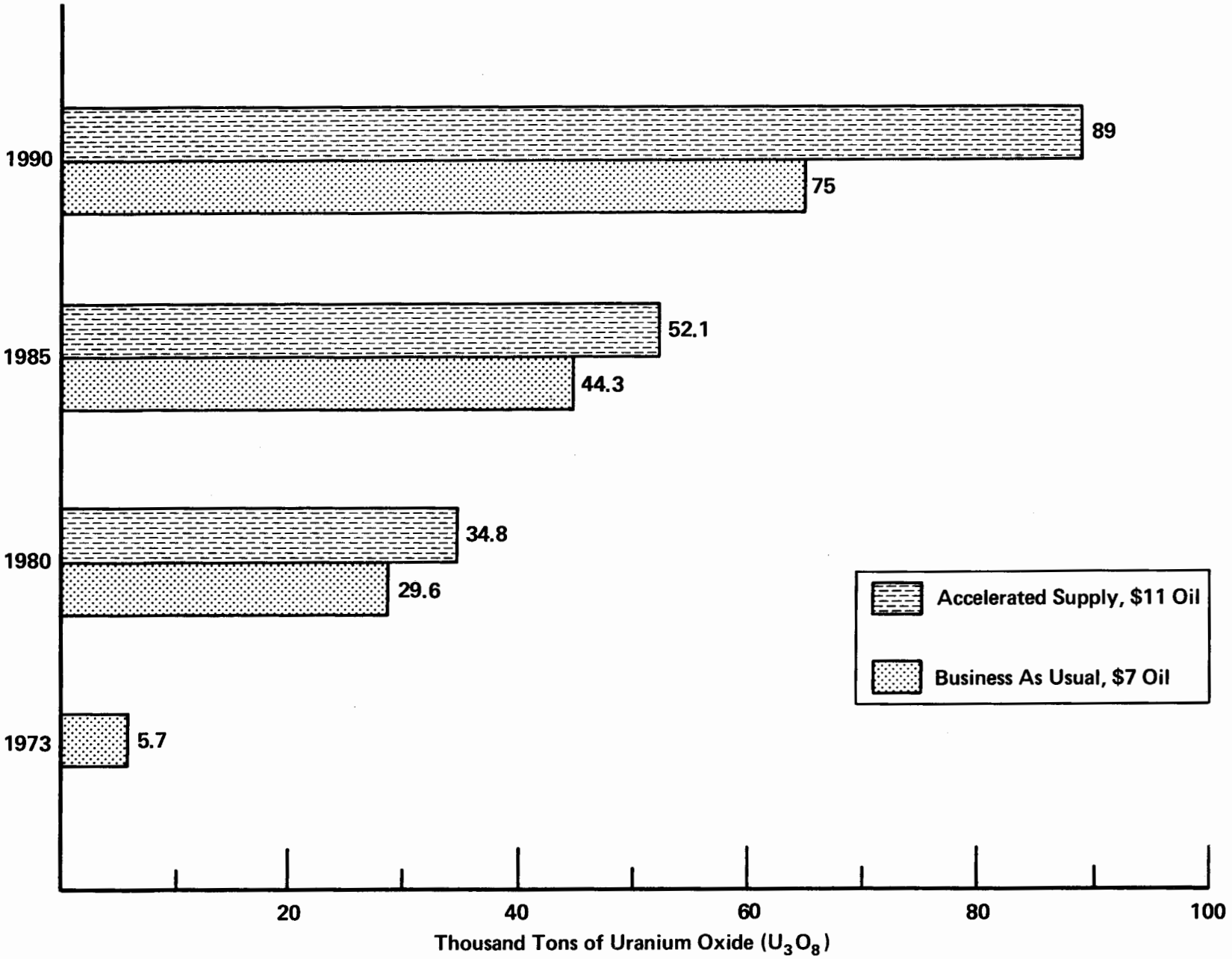
**Nuclear Plant Capacity, Uranium Oxide Requirements, Annual Enrichment, and Annual Reprocessing, 1973-90**

| ITEM | YEAR | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1973 | 1980 | | 1985 | | 1990 | |
| | | BAU | AS | BAU | AS | BAU | AS |
| NUCLEAR PLANT CAPACITY (Thousands of Megawatts) | 20 | 79 | 93 | 204 | 240 | 350 | 410 |
| ANNUAL REQUIREMENTS OF URANIUM ORE ($U_3O_8$) (Thousand Tons)[1] | 5.7 | 29.6 | 34.8 | 44.3 | 52.1 | 76.0 | 89.0 |
| ANNUAL ENRICHMENT (SWU)[2] | 3,400 | 16,094 | 19,900 | 27,795 | 32,700 | 47,688 | 55,863 |
| ANNUAL REPROCESSING (Metric Tons) | 0 | 1,546 | 1,820 | 4,590 | 5,400 | 7,875 | 9,225 |

[1] Enrichment is based upon a 0.2 percent tails assay through 1985, and 0.3 percent thereafter.
[2] SWU, or separate work unit, is equivalent to the amount of effort required to process 1 kilogram of nuclear material.

BAU = business as usual; AS = accelerated supply.

# Projected U.S. Uranium Oxide Requirements, 1973-90[1]




[1] 1973 data refer to enrichment plant feed (AEC low case).

Source: Project Independence Report, 1974, page 113; Nuclear Power Growth 1974-2000, Atomic Energy Commission, 1974, page 46; The Nuclear Industry, Atomic Energy Commission, 1974, 1975; 1985-90 extrapolated.

# U.S. Mill Production of Uranium Oxide

**[1960-73]**

During the 1960-73 period, U.S. Mill production of uranium oxide ($U_3O_8$) decreased at an average annual rate of 2.3 percent.

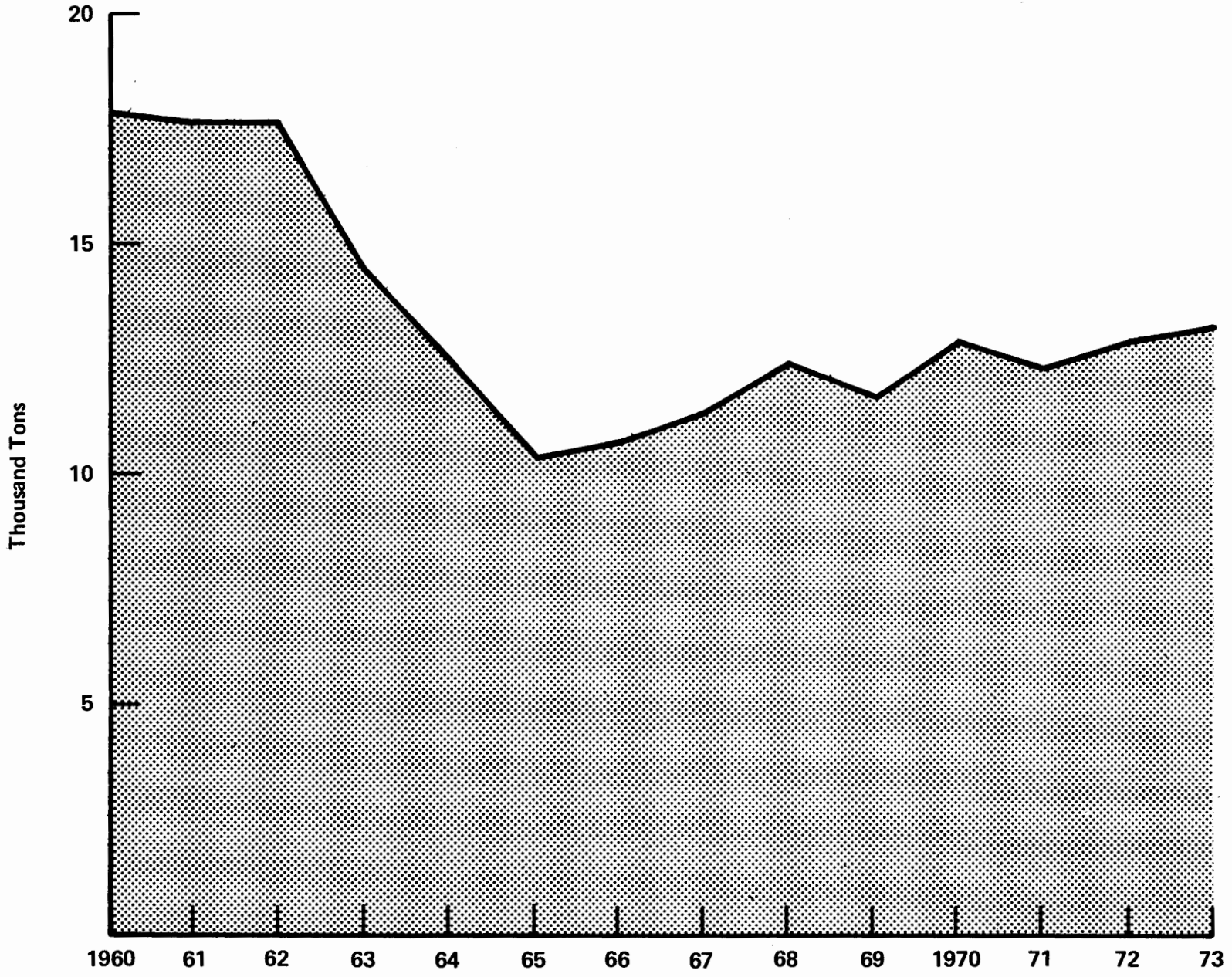
It is estimated that less than 13,000 tons of uranium oxide will be produced in 1974. Because of nuclear power plant capacity projected growth, annual demand for $U_3O_8$ is projected to increase from 10,000 tons in 1975 to 70,000 tons in 1990.

**U.S. Mill Production, Uranium Oxide ($U_3O_8$), 1960-73**

**(Thousands of Tons)**

| YEAR | AMOUNT | YEAR | AMOUNT |
|---|---|---|---|
| 1960 | 17.8 | 1967 | 11.3 |
| 1961 | 17.6 | 1968 | 12.4 |
| 1962 | 17.6 | 1969 | 11.6 |
| 1963 | 14.4 | 1970 | 12.9 |
| 1964 | 12.5 | 1971 | 12.3 |
| 1965 | 10.3 | 1972 | 12.9 |
| 1966 | 10.6 | 1973 | 13.2 |

# U.S. Mill Production, Uranium Oxide ($U_3O_8$), 1960-73




Source: U.S. Bureau of Mines, 1974; The Nuclear Industry, 1974, Atomic Energy Commission, 1975.

# Nuclear Power Plant Lead Time Trends

From 1969 to 1973, nuclear power plant lead times in the United States increased by approximately one-third.

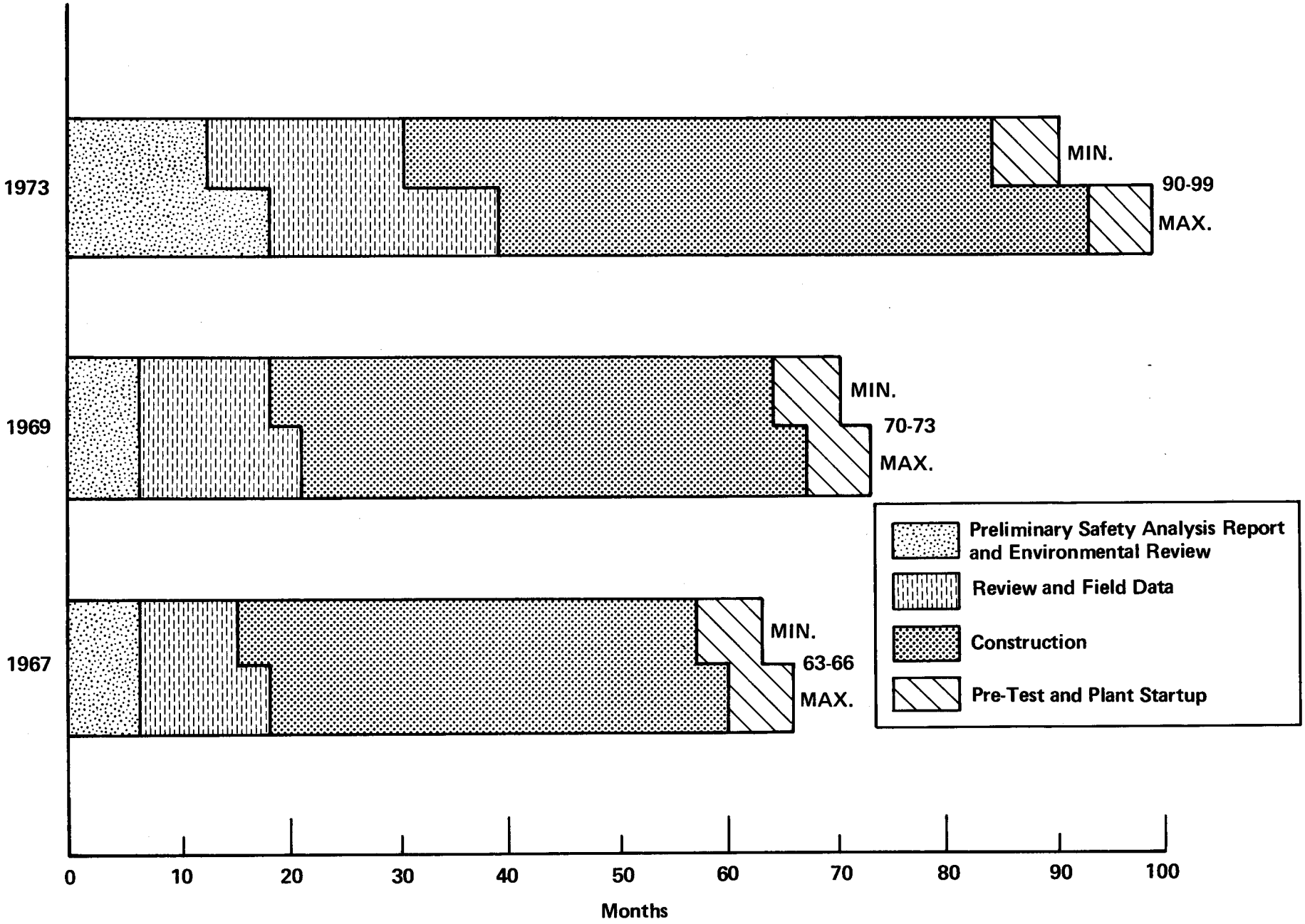
Slippage occurred in the preliminary safety analysis report and environmental review; in the review and field data; and in the construction stages. At present, construction constitutes between 55 and 60 percent of the total lead time.

**Nuclear Power Plant Lead Time Trends**

**(Months)**

| YEAR | PRELIMINARY SAFETY ANALYSIS REPORT AND ENVIRONMENTAL REVIEW | REVIEW AND FIELD DATA | CONSTRUCTION | PRETEST AND PLANT STARTUP | TOTAL |
|---|---|---|---|---|---|
| 1967 | 6 | 9-12 | 42 | 6 | 63-66 |
| 1969 | 6 | 12-15 | 46 | 6 | 70-73 |
| 1973 | 12-18 | 18-21 | 54 | 6 | 90-99 |

# Nuclear Power Plant Lead Time Trends




Source: Power Plant Capital Costs: Current Trends and Sensitivity to Economic Parameters, Atomic Energy Commission, 1974, page 60.

# U.S. Hydroelectric Power

**[by Region]**

In 1973, 53 percent of total hydroelectric power capacity in the United States was located in the Pacific region. New England, the Middle Atlantic, the East North Central, the West North Central, the South Atlantic, the East South Central, and the West South Central States possessed 29 percent of total U.S. capacity.

Hydroelectric power contributed 15 percent of total capacity of the electrical utility industry in 1973.

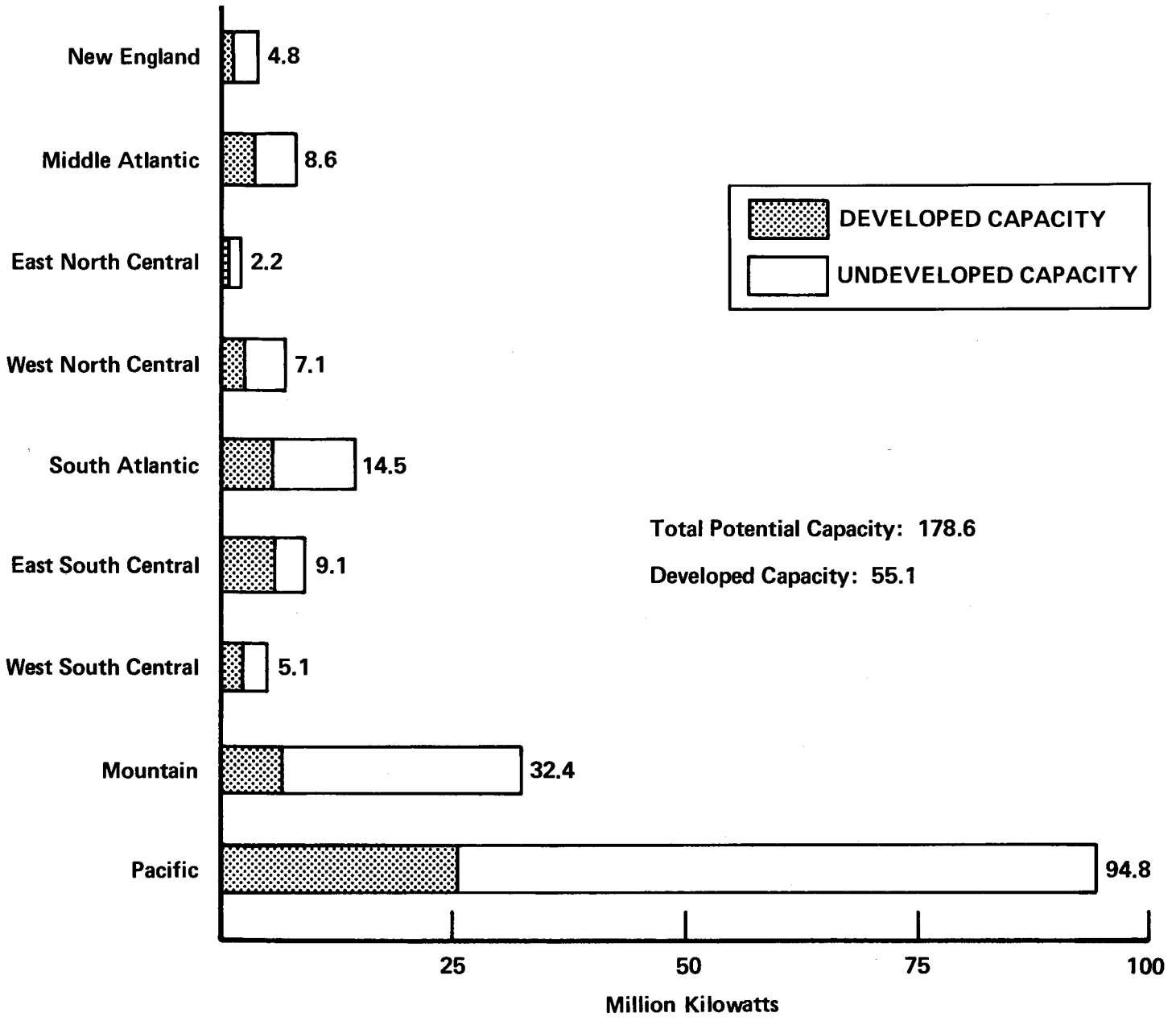
The United States developed 31 percent of its potential hydroelectric power capacity as compared to the world average of 15 percent in 1973.

**U.S. Hydroelectric Power by Region, 1973**

**(Millions of Kilowatts)**

| REGION | TOTAL POTENTIAL CAPACITY | TOTAL DEVELOPED CAPACITY |
|---|---|---|
| NEW ENGLAND | 4.8 | 1.5 |
| MIDDLE ATLANTIC | 8.6 | 4.2 |
| EAST NORTH CENTRAL | 2.2 | .9 |
| WEST NORTH CENTRAL | 7.1 | 2.8 |
| SOUTH ATLANTIC | 14.5 | 5.5 |
| EAST SOUTH CENTRAL | 9.1 | 5.4 |
| WEST SOUTH CENTRAL | 5.1 | 2.3 |
| MOUNTAIN | 32.4 | 6.7 |
| PACIFIC | 94.8 | 25.8 |
| TOTAL | 178.6 | 55.1 |

# U.S. Hydroelectric Power by Region, 1973




Source: Federal Power Commission, 1974.

# U.S. Oil Shale Deposits

**[Green River Formation]**

Of the known higher grade U.S. oil shale resource base of approximately 418 billion barrels,[1] approximately 84 percent of the reserves are located in Colorado, 12 percent in Utah, and 3 percent in Wyoming. The oil shale reserve base is contained within a 25,000-square-mile area.

Although Colorado has the smallest geographical area of oil shale deposits, these deposits are the richest, thickest, and best defined resources. About 75 percent of the known deposits are in the Piceance Creek Basin of Colorado.

Known Green River Formation deposits include high-grade shales that represent 600 billion barrels of oil. An additional 12 billion barrels are contained in lower grade shales.

Federal oil shale lands constitute 72 percent of oil shale lands in Colorado, Utah, and Wyoming.

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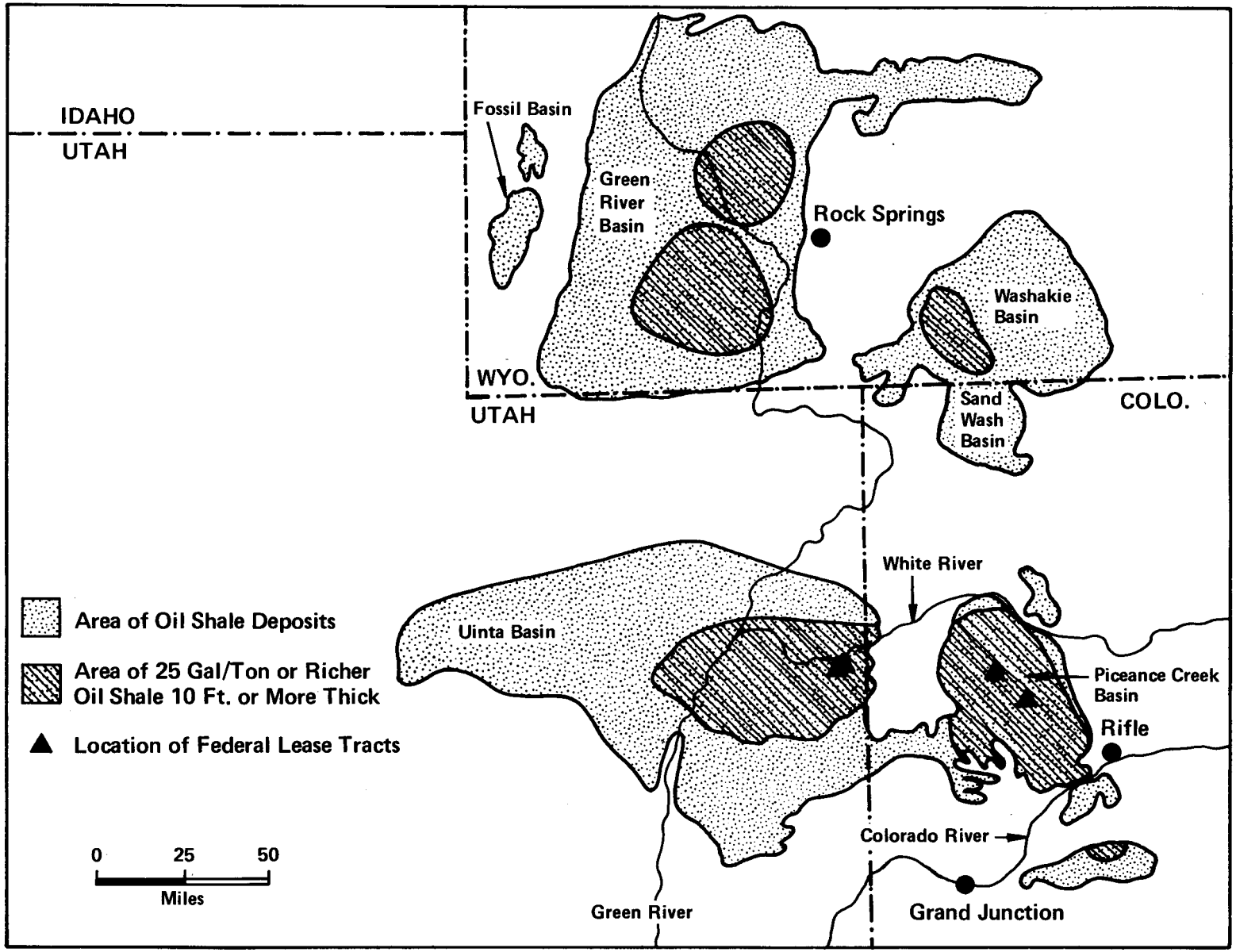
[1] Identified resources of 25 gallons of shale oil per ton of oil shale or greater.

# U.S. Oil Shale Deposits, Green River Formation



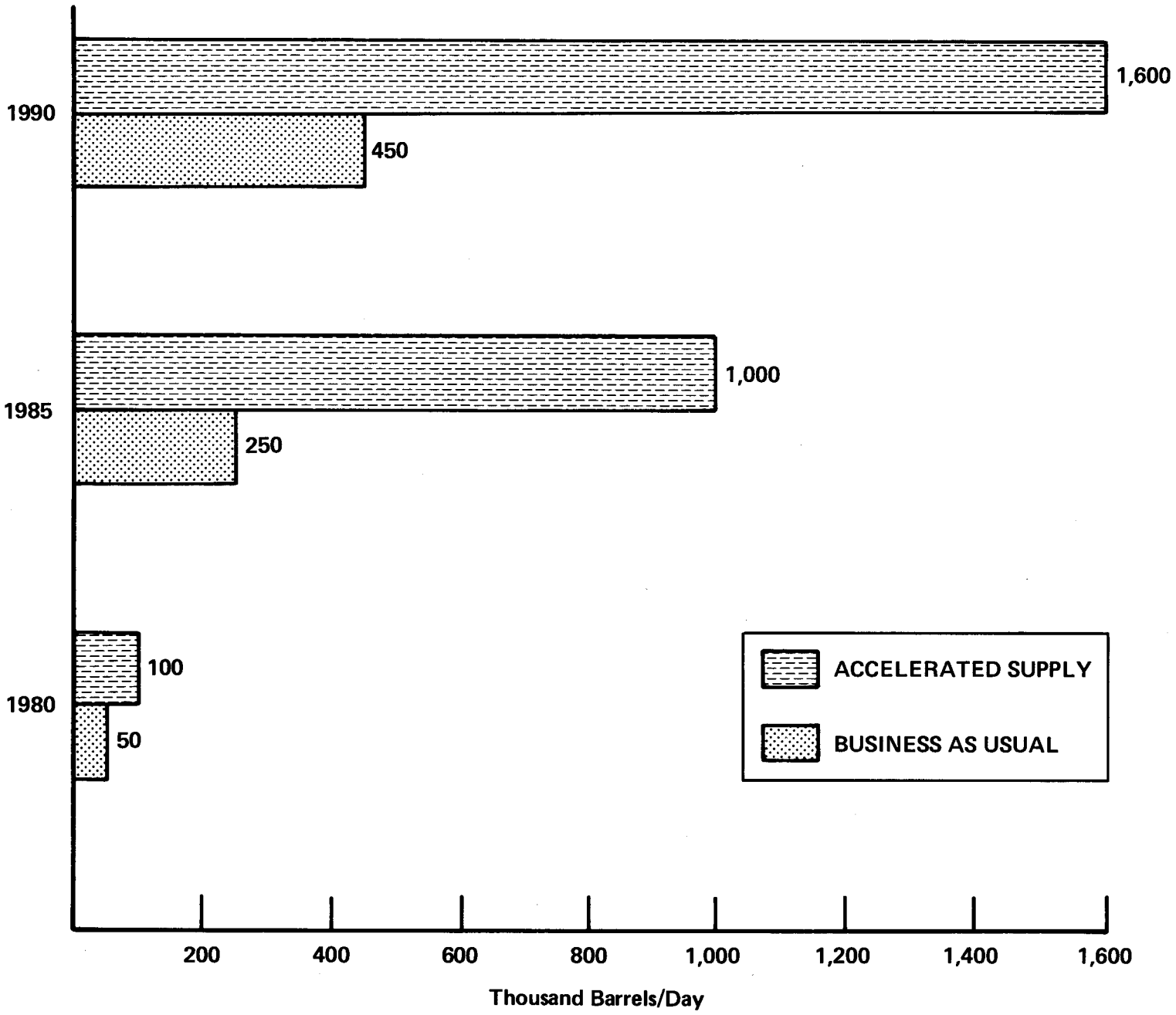

Source: U.S. Department of the Interior, 1973.

# U.S. Shale Oil Production Potential

Given accelerated supply, production of shale oil is projected to reach a million barrels a day in 1985, or approximately 9 percent of 1974 U.S. petroleum production. Between 1985 and 1990, the annual rate of growth in shale oil production is projected at 9.9 percent.

Shale oil production under business as usual would reach 450,000 barrels a day in 1990, or 4 percent of 1974 petroleum production in the United States.

# U.S. Shale Oil Production Potential, 1980-90



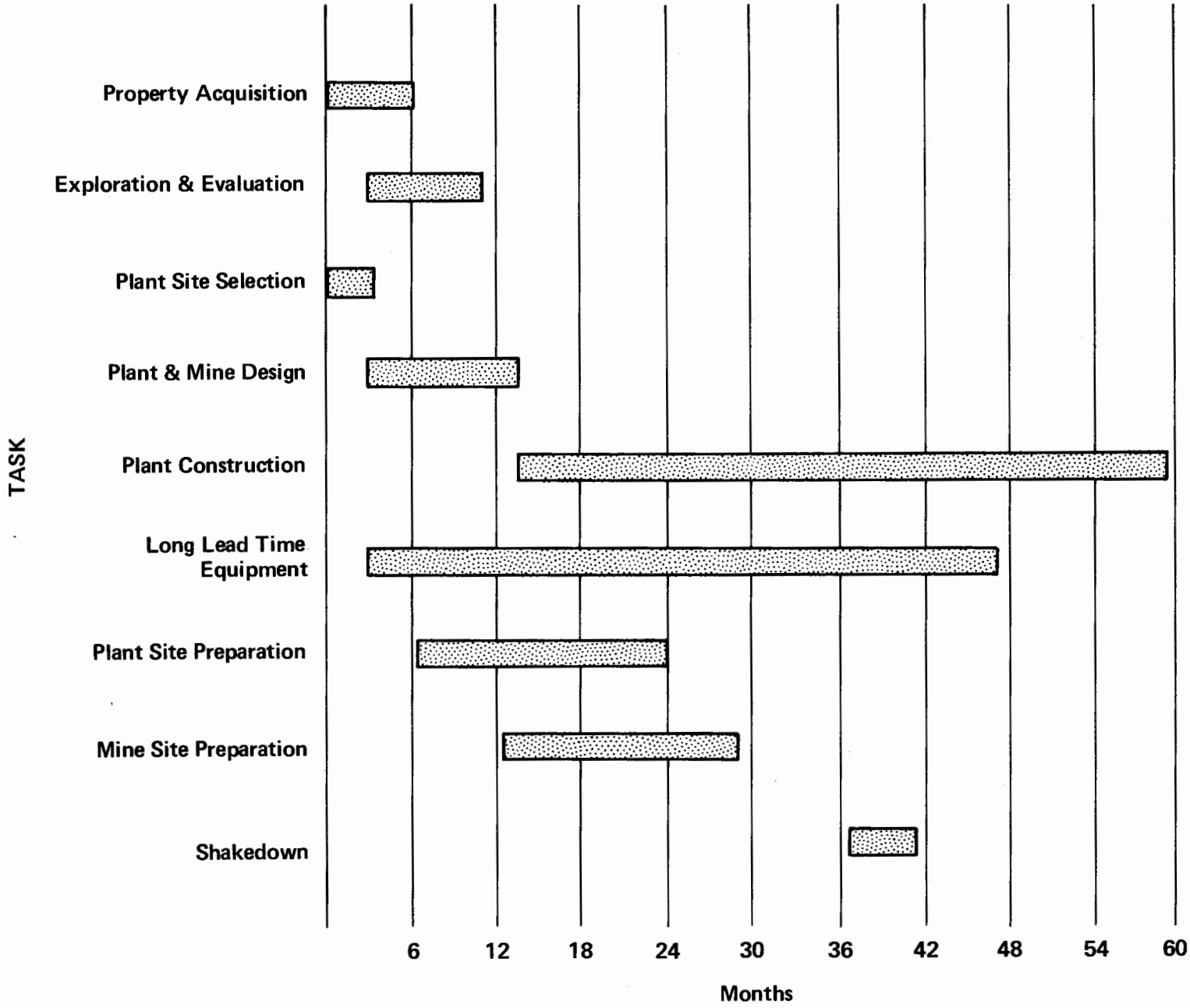

Source: Potential Future Role of Oil Shale; Prospects and Constraints, Project Independence Report, 1974, page 36.

# Shale Oil Production Lead Times

Five years is the best available estimate of the average lead time needed for completion of a shale oil production operation. This lead time assumes a concurrent activities schedule.

Plant construction activity should take approximately 4 years.

# Shale Oil Production Lead Times, Concurrent Activities Schedule




Source: Potential Future of Oil Shale: Prospects and Constraints, Project Independence Report, 1974, page 301.

# Land Impacts, Shale Oil Production

Under accelerated supply, the cumulative total acres of land disturbed by oil shale production in 1985 will be 260 percent greater than under business as usual.

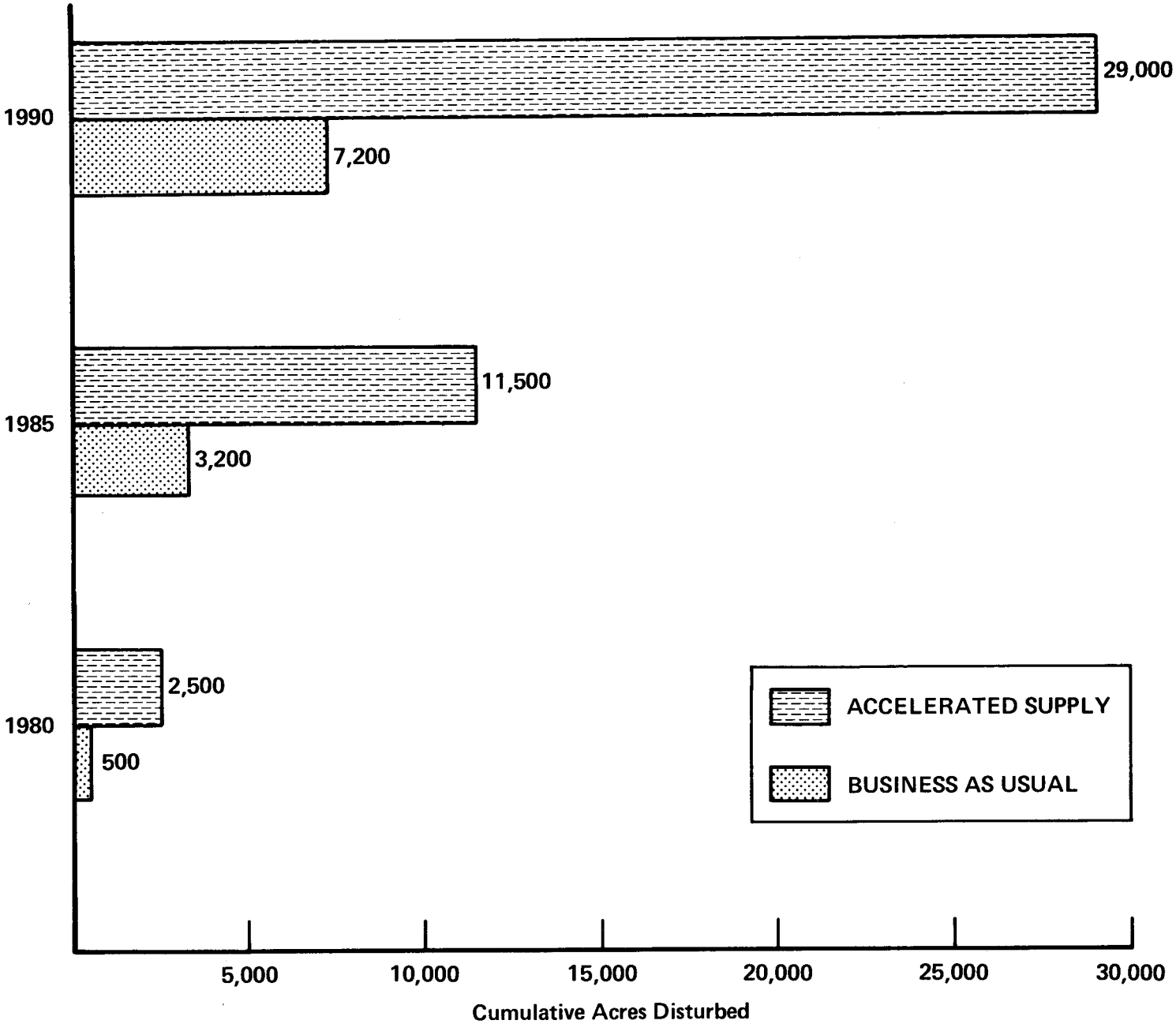
In 1990, it is estimated that production of 1.6 million barrels of shale oil a day, under an accelerated development strategy, would disturb 29,000 acres of land.

**Land Impacts, Shale Oil Production[1], 1980-90**

| YEAR | BUSINESS AS USUAL | | ACCELERATED SUPPLY | |
|---|---|---|---|---|
| | CUMULATIVE LAND DISTURBED (Acres) | ASSOCIATED SHALE OIL PRODUCTION (Barrels Per Day) | CUMULATIVE LAND DISTURBED (Acres) | ASSOCIATED SHALE OIL PRODUCTION (Barrels Per Day) |
| 1980 | 500 | 50,000 | 2,500 | 100,000 |
| 1985 | 3,200 | 250,000 | 11,500 | 1,000,000 |
| 1990 | 7,200 | 450,000 | 29,000 | 1,600,000 |
| 2015 | 21,000 | 450,000 | 78,000 | 1,600,000 |

[1] Impacts resulting from urban area growth and development of utility corridors are not included.

# Land Impacts, Shale Oil Production, 1980-90




Source: Potential Future Role of Oil Shale: Prospects and Constraints, Project Independence Report, 1974, page 8.

# U.S. Geothermal Resource Areas

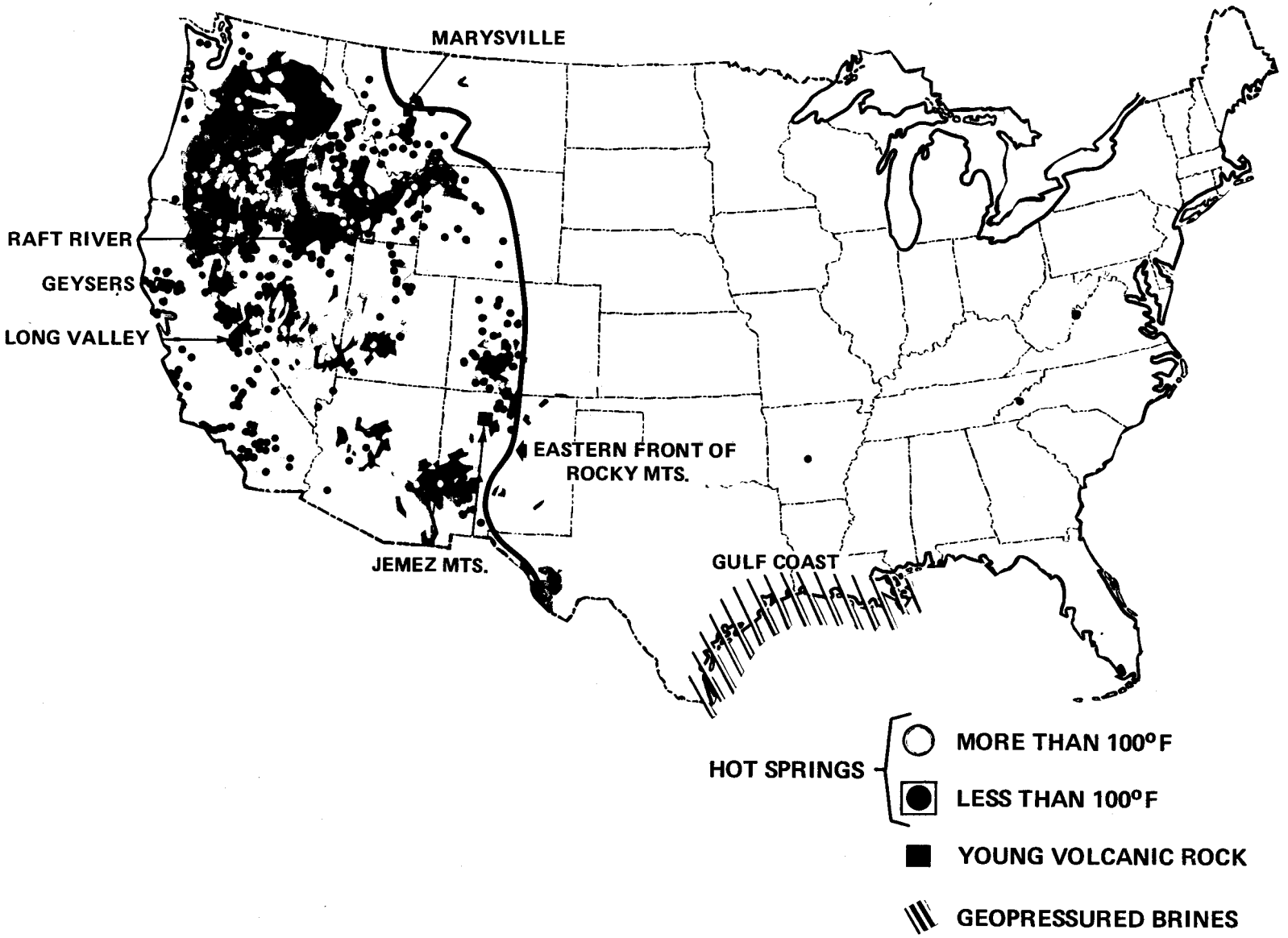
**[Areas of Promise]**

Most geothermal resource areas of promise in the United States are located in the Western and Rocky Mountain States.

However, geopressured brine resource areas of promise are located in the Gulf Coast States.

At present, geothermal energy is used only at the geysers for producing electricity. Existing geothermal capacity is 396 megawatts, or less than 1 percent of total U.S. generating capacity.

# U.S. Geothermal Resources, Areas of Promise




Source: U.S. Geological Survey, 1974.

# 1975-85 Energy Facility Cumulative Capital Requirements

Cumulative capital requirements needed to implement the accelerated supply scenario of Project Independence for the 1975-85 period are estimated at $454 billion. This amount does not include lease bonus payments, outlays expensed for tax purposes, or investments required for tanker fleets.

Twenty-two percent of the Project Independence capital costs estimate is for oil and gas sector expenditures, 31 percent for nuclear energy expenditures, and 26 percent for electrical transmission capital requirements.

An independent study by the National Academy of Engineering[1] of capital requirements for the 1974-85 period, estimated requirements to range from $490 billion to $610 billion.

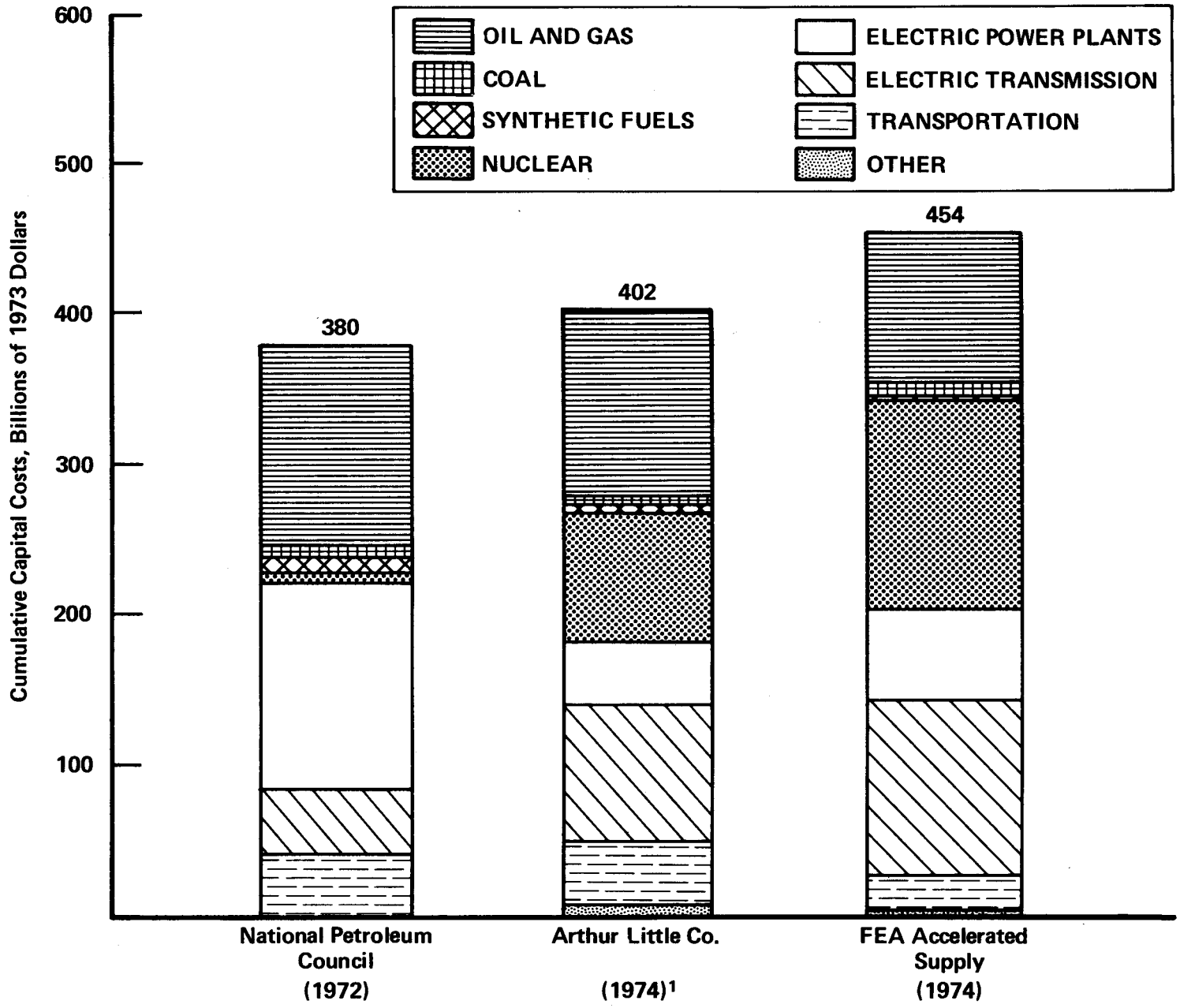
**Energy Facility Cumulative Capital Requirements, 1975-85**
**(Billions of 1973 Dollars)**

| ITEM | NATIONAL PETROLEUM COUNCIL | ARTHUR LITTLE CO. | FEA ACCELERATED SUPPLY |
|---|---|---|---|
| OIL AND GAS (Including Refining) | 133 | 122 | 98.4 |
| COAL | 8 | 6 | 11.9 |
| SYNTHETIC FUELS | 10 | 6 | .6 |
| NUCLEAR | 7 | 84 | 138.5 |
| ELECTRIC POWER PLANTS (Excluding Nuclear) | 137 | 43 | 60.3 |
| ELECTRIC TRANSMISSION | 42 | 90 | 116.2 |
| TRANSPORTATION | 43 | 43 | 25.5 |
| OTHER | – | 8 | 2.2 |
| TOTAL | 380 | 402 | 453.6 |

[1] Based upon an energy conservation scenario.

[1] U.S. Energy Prospects, An Engineering Viewpoint, National Academy of Engineering, 1974, page 96.

# Energy Facility Cumulative Capital Requirements, 1975-85




[1] Estimate is based upon an energy conservation scenario.

Source: Project Independence Report, 1974, page 282.

# U.S. Energy Facility Production Lead Times

Minimum significant production[1] lead times for new Outer Continental Shelf (OCS) fields in the Atlantic range from 6 to 10 years, and from 8 to 12 years in the Gulf of Alaska.

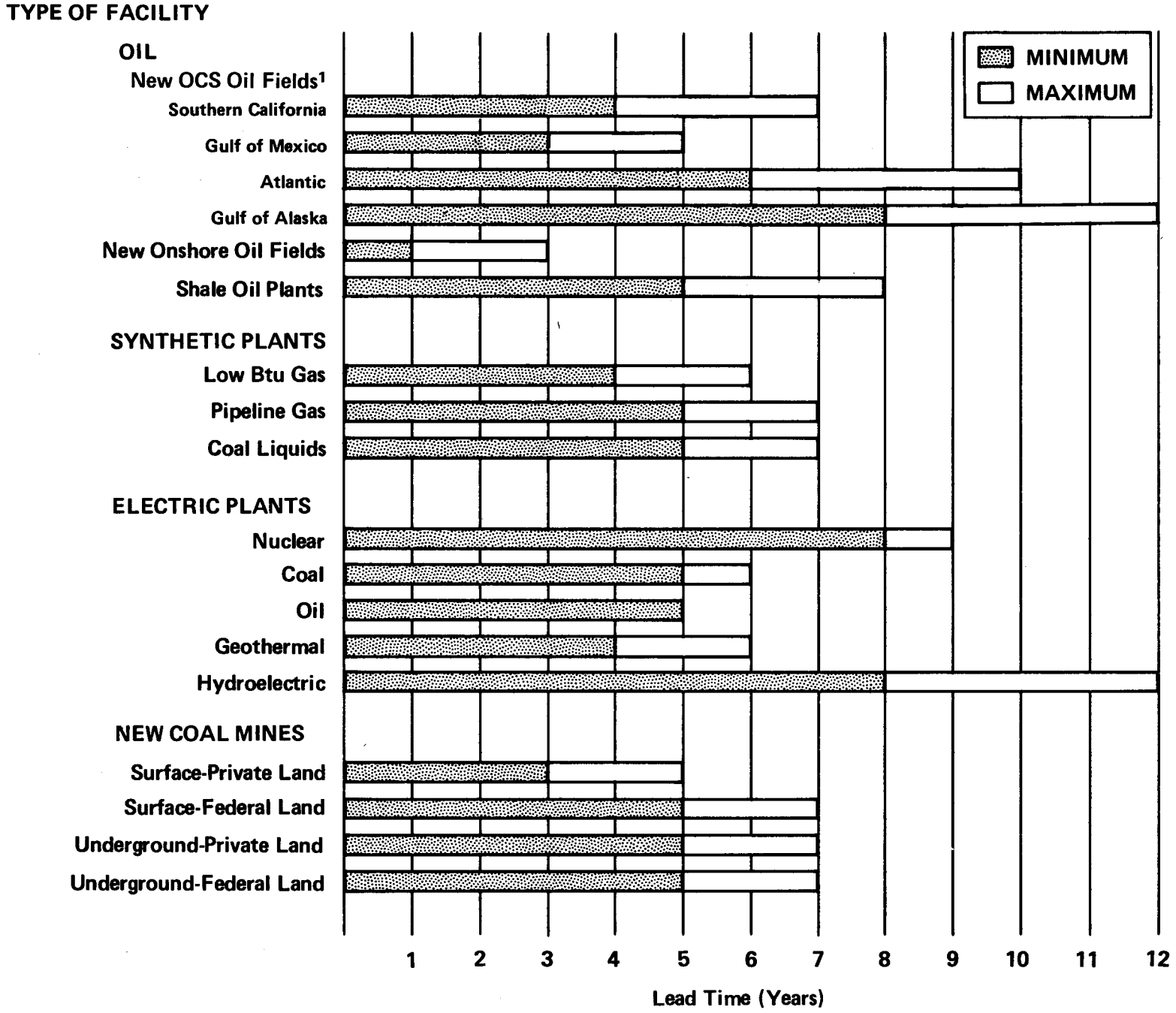
Lead times for the development of shale oil producing plants range from 5 to 8 years.

Production from new coal mines will take from 3 to 5 years.

The range in the energy facility production lead times reflects the uncertainties that may arise from the inception of a project to its completion.

[1] Significant production exists when gathering systems and pipelines will be constructed or connected to OCS wells.

# U.S. Energy Facility Production Lead Times




[1]Significant production.

Source: U.S. Department of the Interior; U.S. Energy Prospects: An Engineering Viewpoint, National Academy of Engineering, 1973, page 92.

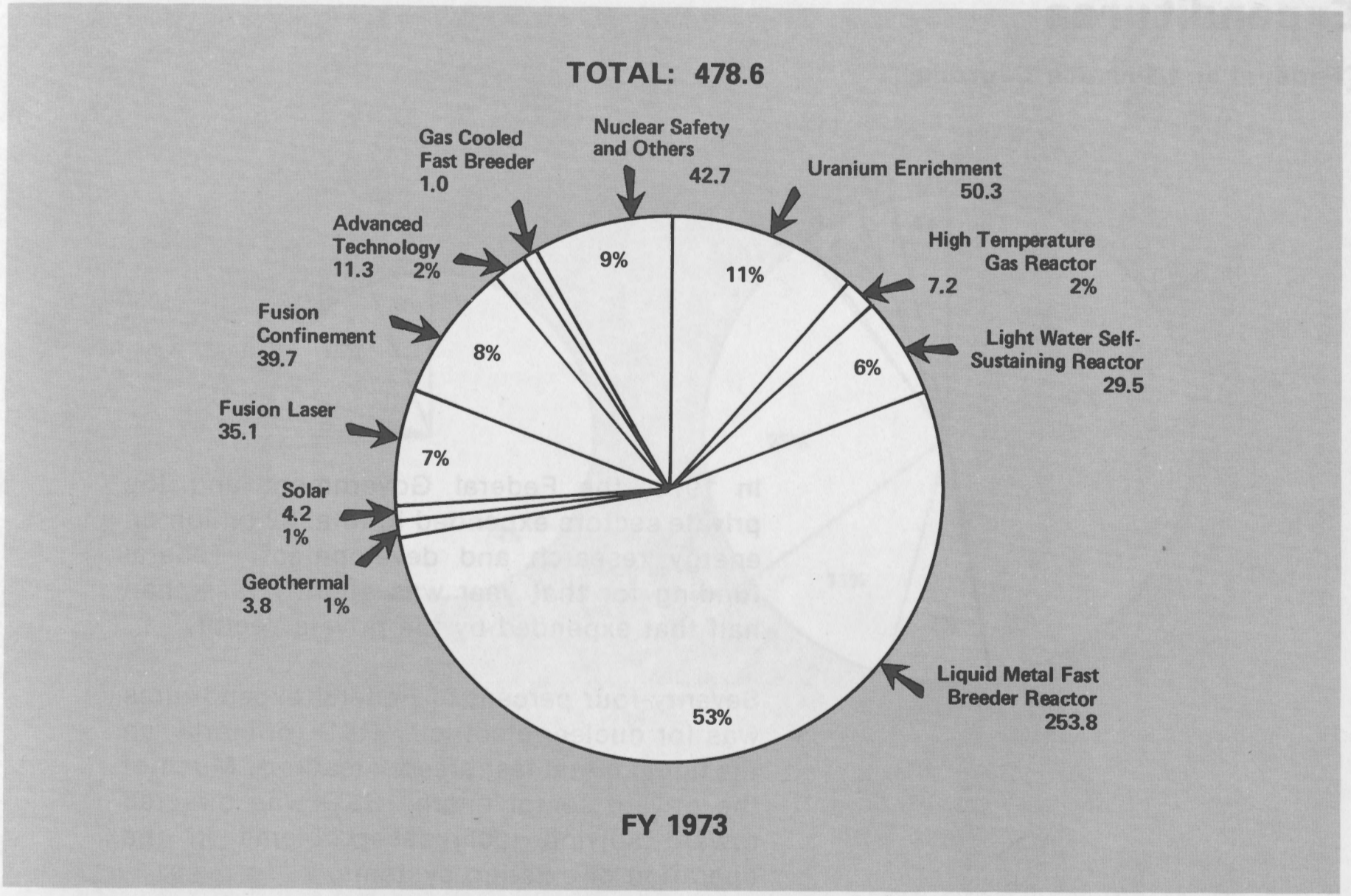
# Federal Funding, Nuclear and Renewable Energy R&D

In 1973, 53 percent of nuclear and renewable energy R&D was directed toward the development of the liquid metal fast breeder reactor.

Fusion confinement and fusion laser research efforts constituted 15 percent of total Federal nuclear and renewable energy R&D in 1973, while renewable energy source, solar and geothermal R&D constituted but 2 percent of total expenditures.

# Federal Funding, Nuclear and Renewable Energy R&D, 1973[1]

($ Million)




[1]Data are based upon estimated fiscal year 1973 expenditures.

Source: The Nation's Energy Future, Atomic Energy Commission, 1973, page 29.

# U.S. Energy R&D Expenditures

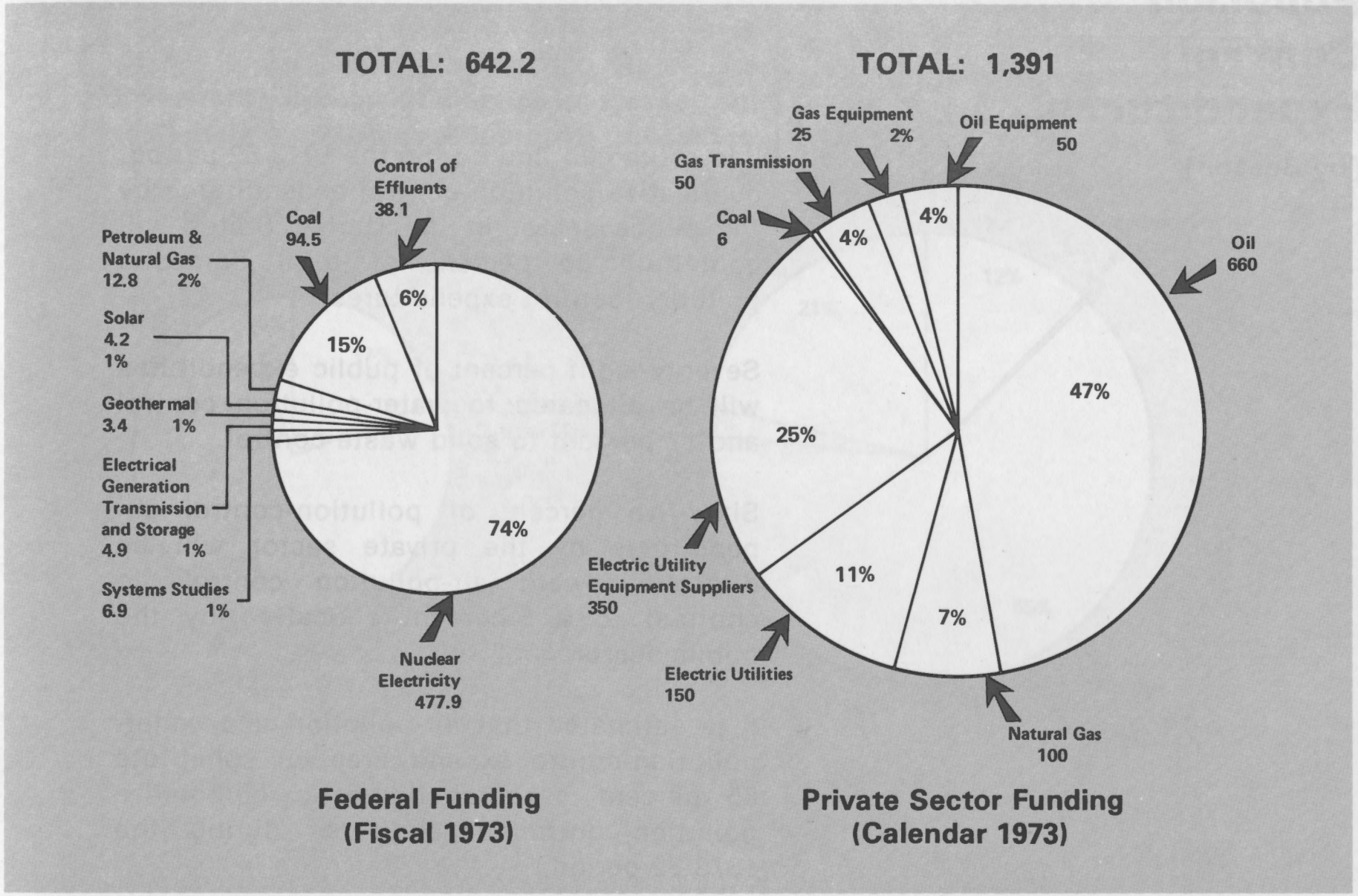
**[Federal and Private Sectors]**

In 1973, the Federal Government and the private sectors expended in total $2 billion on energy research and development. Federal funding for that year was slightly less than half that expended by the private sector.

Seventy-four percent of Federal expenditures was for nuclear electricity R&D (primarily on the liquid metal fast breeder reactor). Much of the private sector energy R&D was directed toward solving technical problems in the operation of existing systems.

# U.S. Energy R&D Expenditures, Federal and Private Sectors, 1973

($Million)




Source: The Nation's Energy Future, Atomic Energy Commission, 1973, page 29; A Time to Choose, Ford Foundation, 1974, pages 307-308.

# Projected U.S. Pollution Control Expenditures

**[by Sector]**

It is estimated that during the 1973-82 period, cumulative pollution-control expenditures by the public sector in the United States will constitute 35 percent of total domestic pollution-control expenditures.

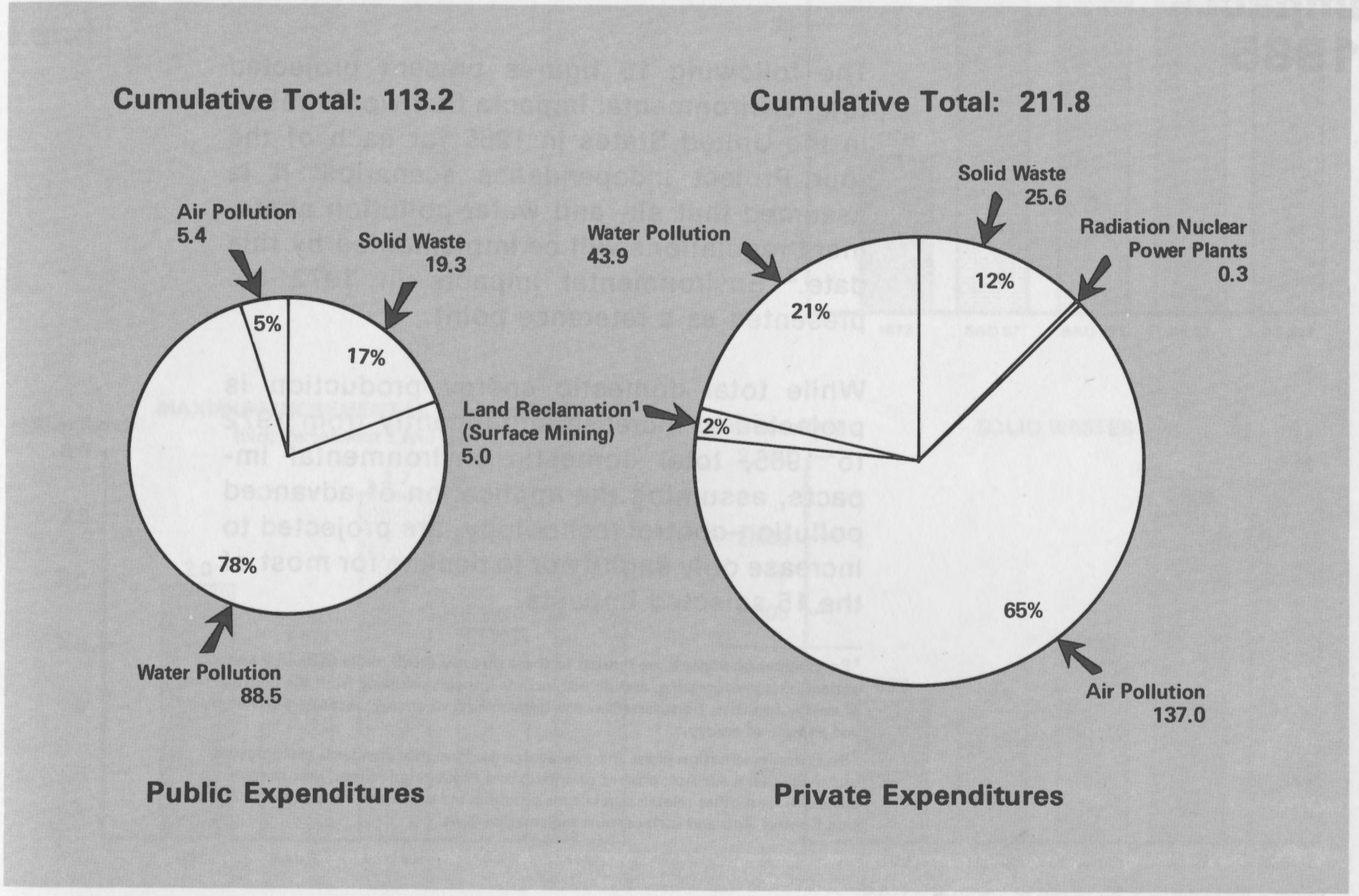
Seventy-eight percent of public expenditures will be allocated to water-pollution control and 17 percent to solid waste control.

Sixty-five percent of pollution-control expenditures by the private sector will be directed toward air-pollution control, in contrast to a 5-percent allocation by the public sector.

It is estimated that air-pollution and water-pollution-control expenditures will constitute 85 percent of total domestic cumulative pollution-control expenditures during the 1973-82 period.

# Projected U.S. Pollution Control Expenditures, 1973-82

**(Billions of 1973 Dollars)**




[1] Related to coal mining.

Source: Fifth Annual Report, Council on Environmental Quality, 1974.

# Projected Environmental Impacts[1] 1985

The following 15 figures present projected total environmental impacts that would result in the United States in 1985 for each of the four Project Independence scenarios. It is assumed that air- and water-pollution abatement regulations will be implemented by this date.[2] Environmental impacts in 1972 are presented as a reference point.

While total domestic energy production is projected to increase significantly from 1972 to 1985, total domestic environmental impacts, assuming the application of advanced pollution-control technology, are projected to increase only slightly or to decline for most of the 15 selected impacts.

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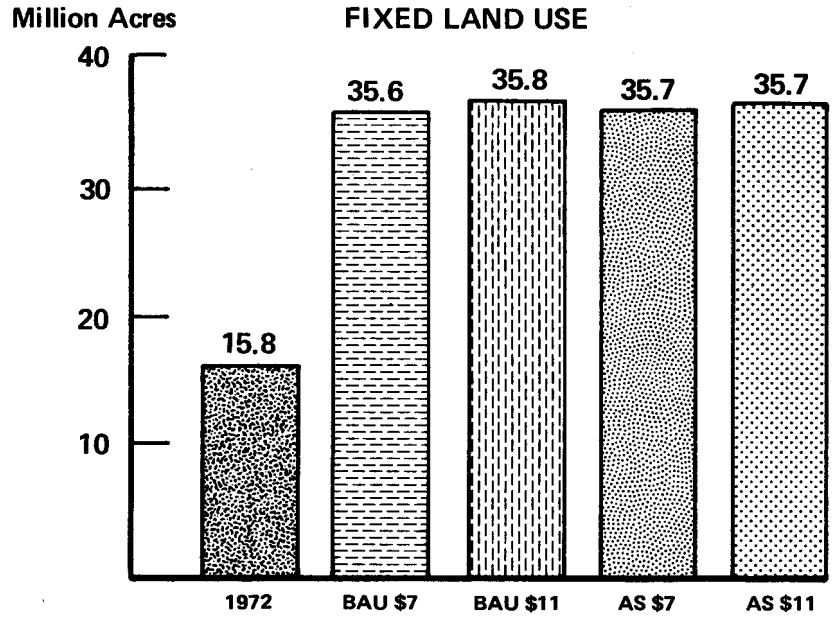
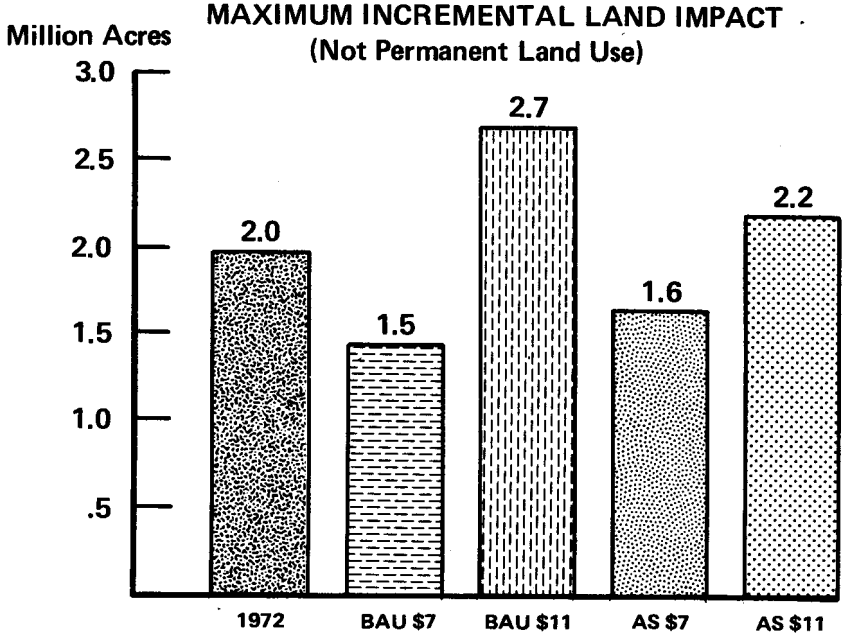
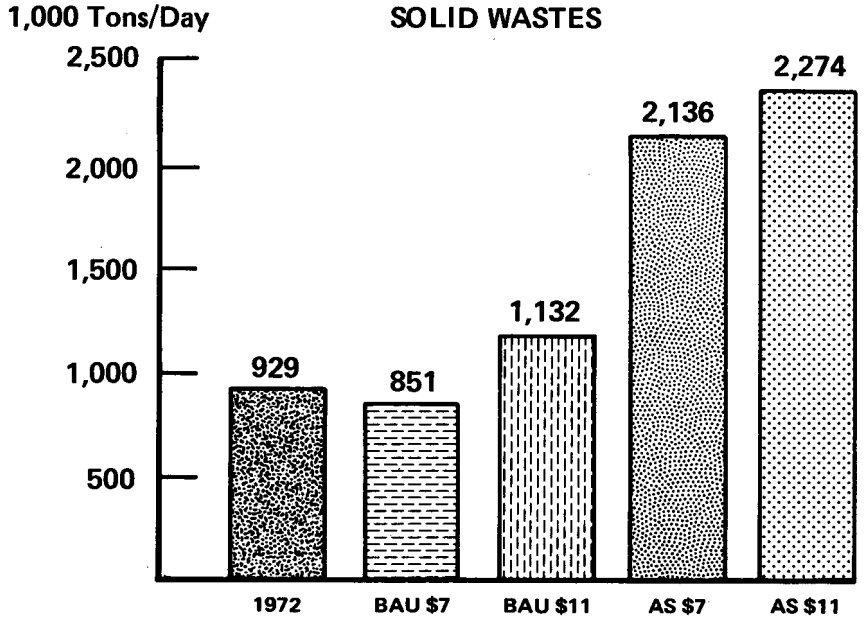
[1] Environmental impacts are limited to those directly attributable to energy material extraction and processing, and do not include impacts resulting from the construction of energy facilities, transportation and transmission of energy, secondary development, and end use of energy.

[2] State implementation plans and new source performance standards promulgated under the Clean Air Act; present or anticipated effluent guidelines, new source standards, and other related regulations promulgated under the Federal Water Pollution Control Act; and surface mine reclamation laws.

# Land



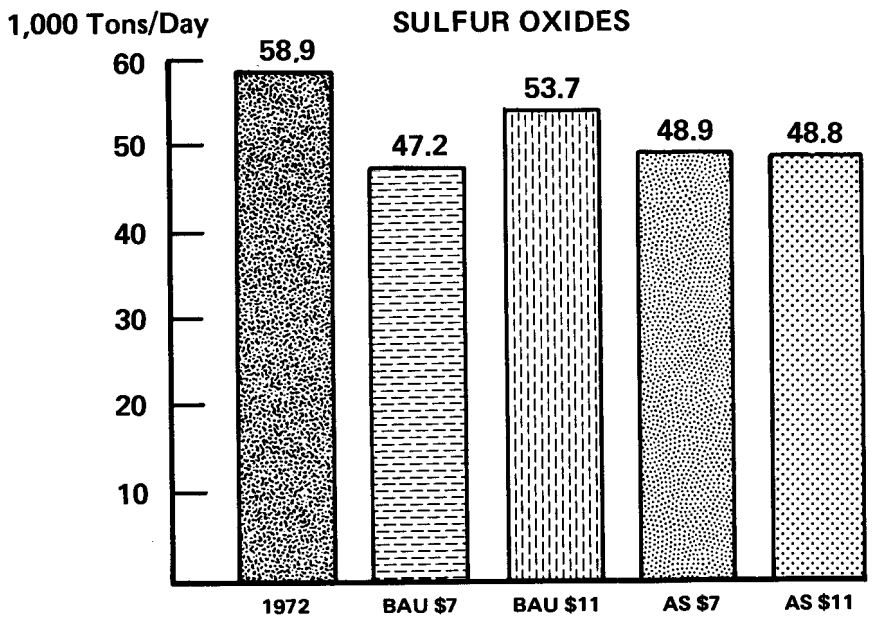



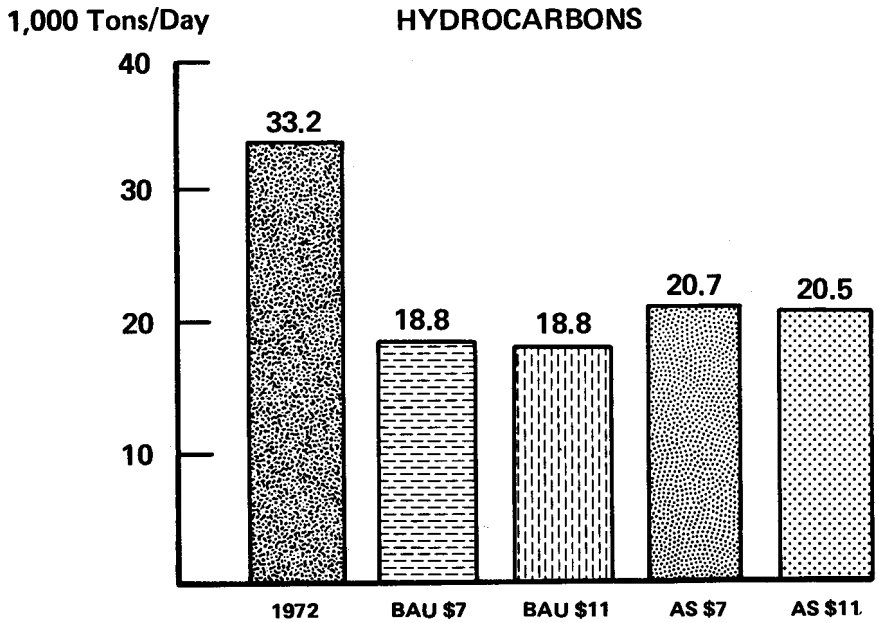



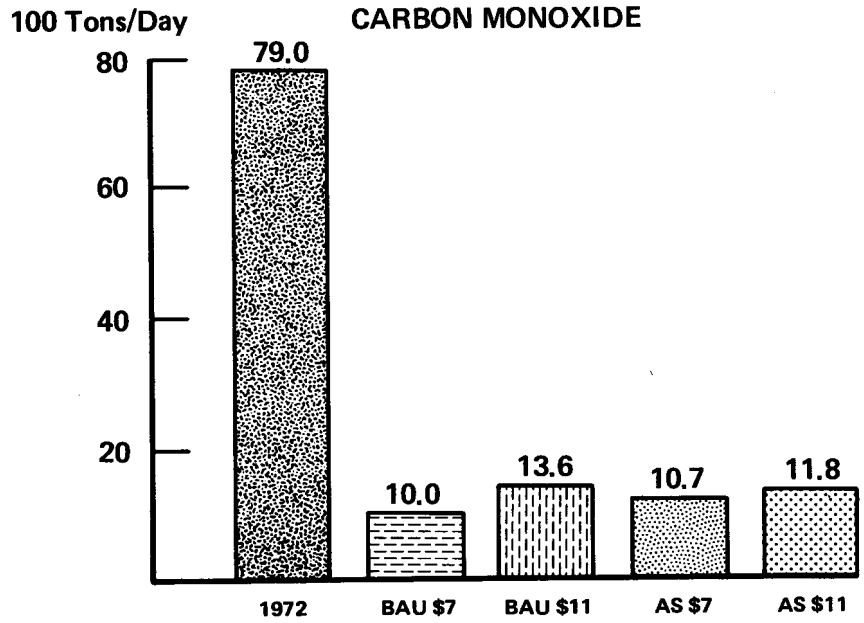

BAU = business as usual; AS = accelerated supply

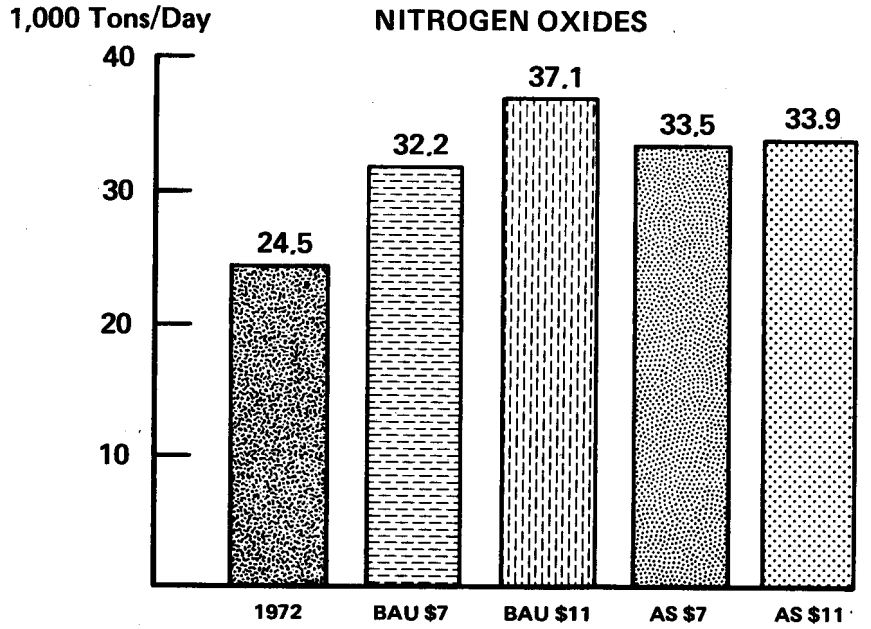
# Projected Environmental Impacts[1], 1985

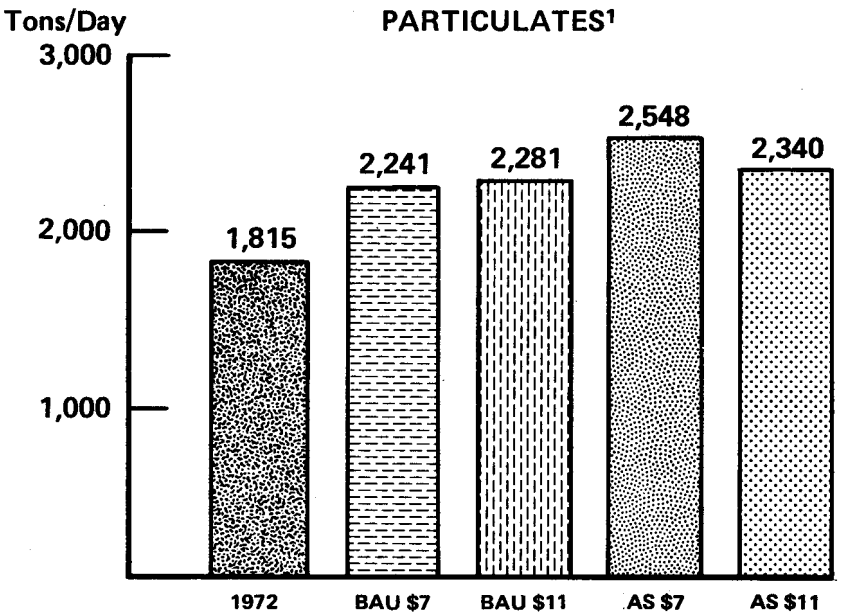
## Air



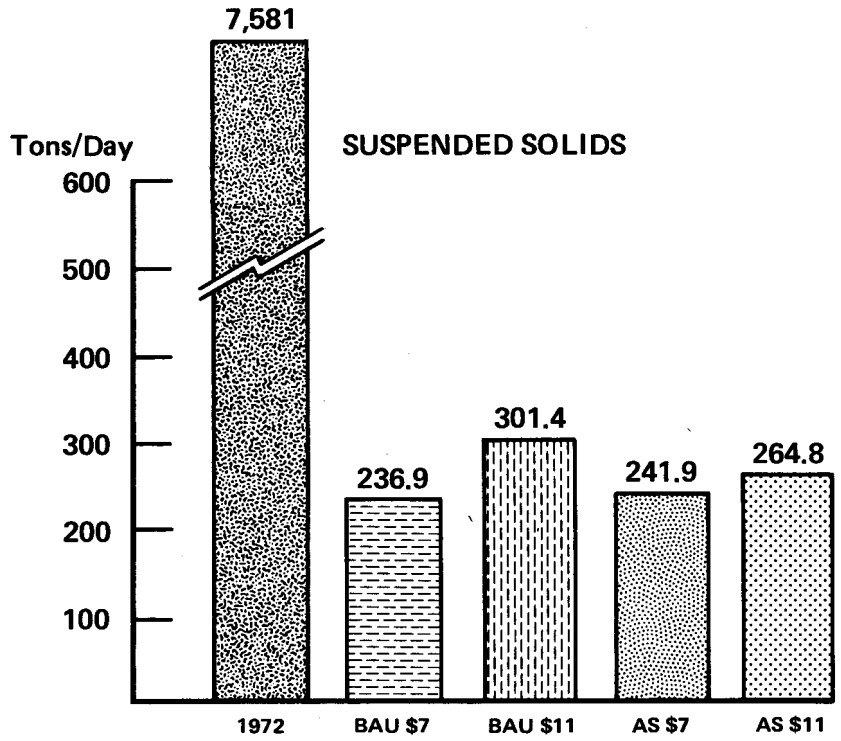


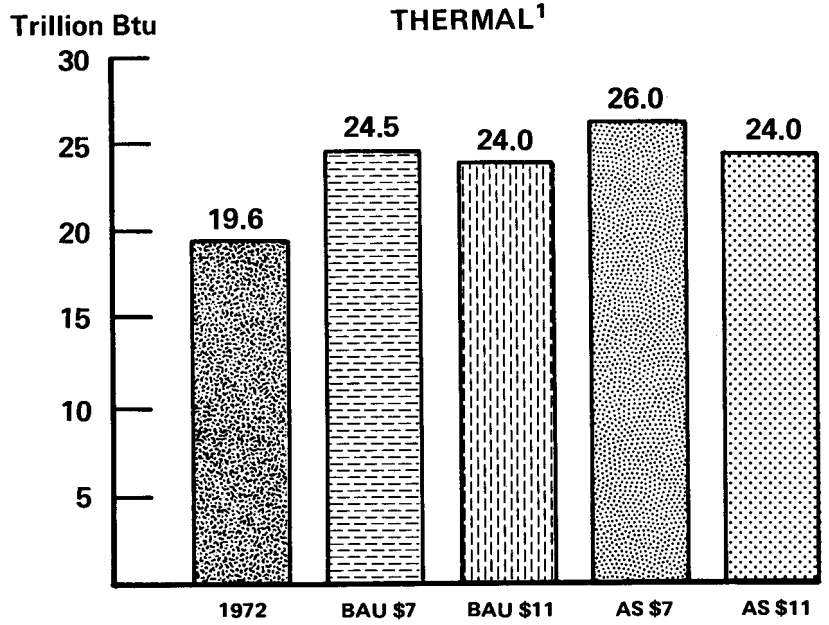



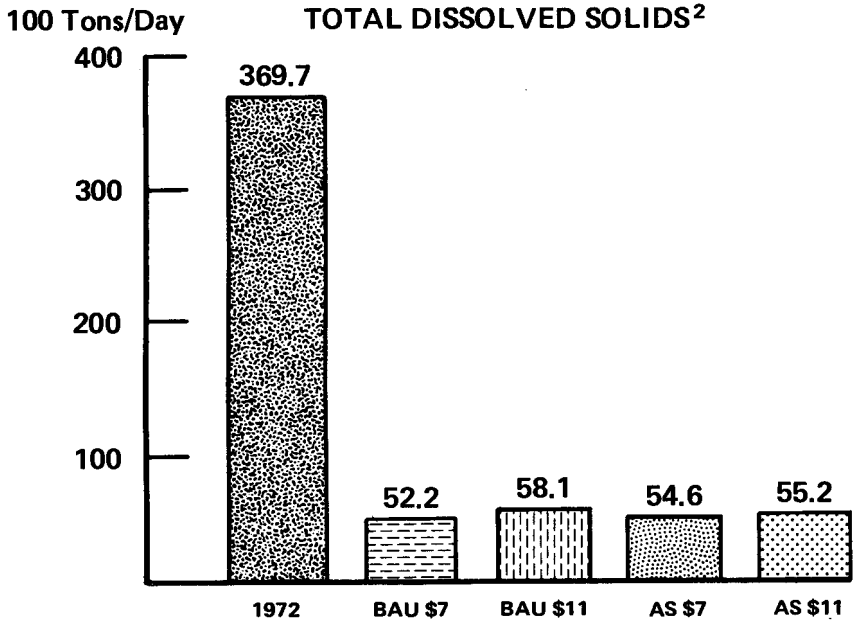

[1]Major sources of particulates in 1985 are coal- and oil-fired electrical generation, oil refining, and oil shale processing. It is assumed that national ambient air quality standards have been promulgated.

# Projected Domestic Environmental Impacts[1], 1985

## Water

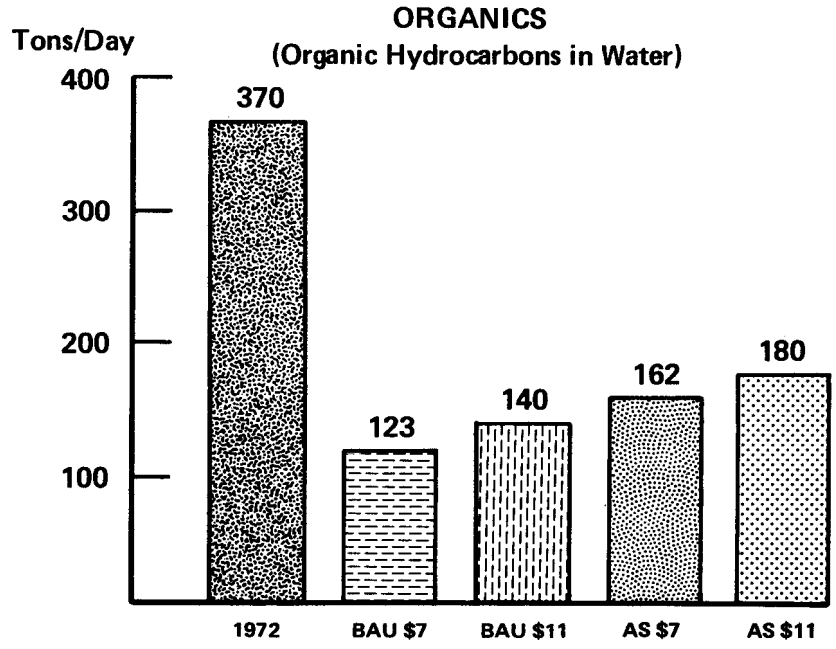


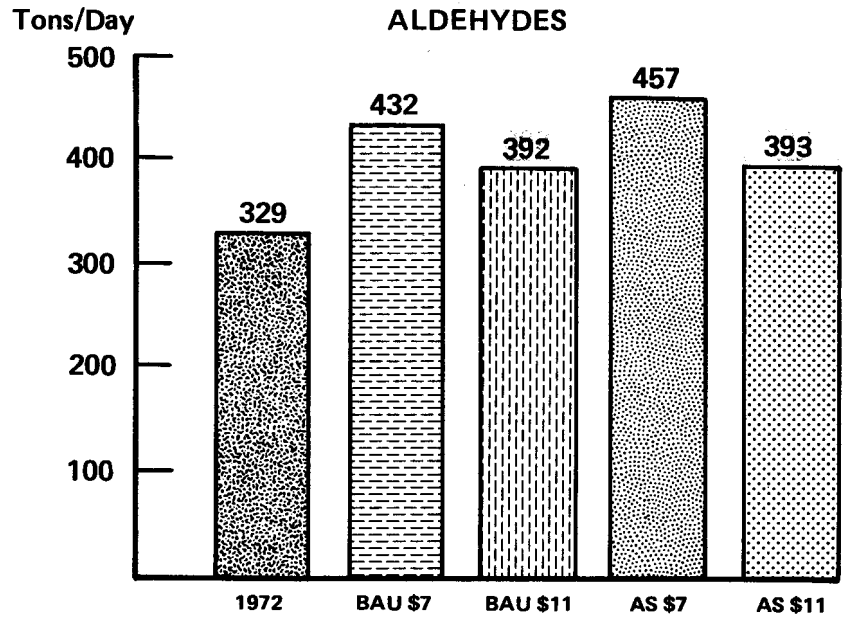



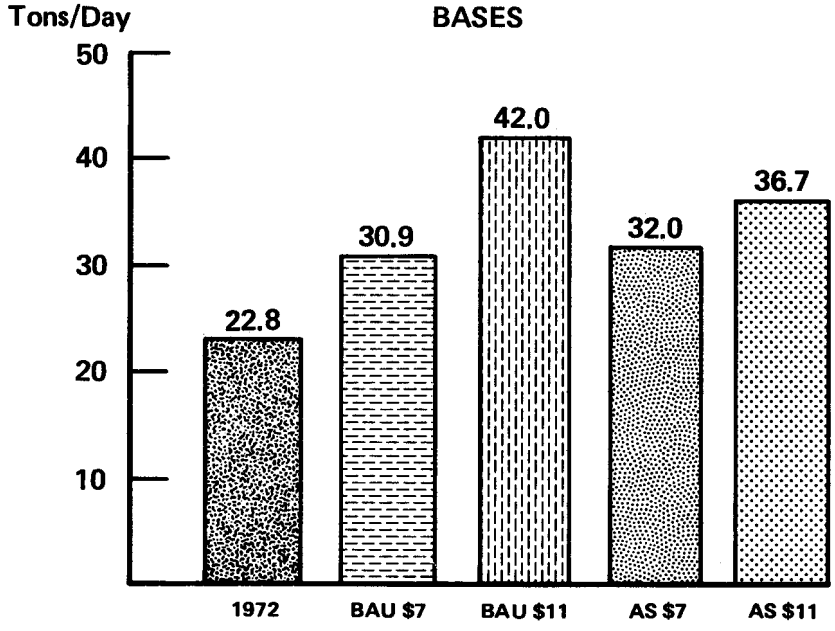



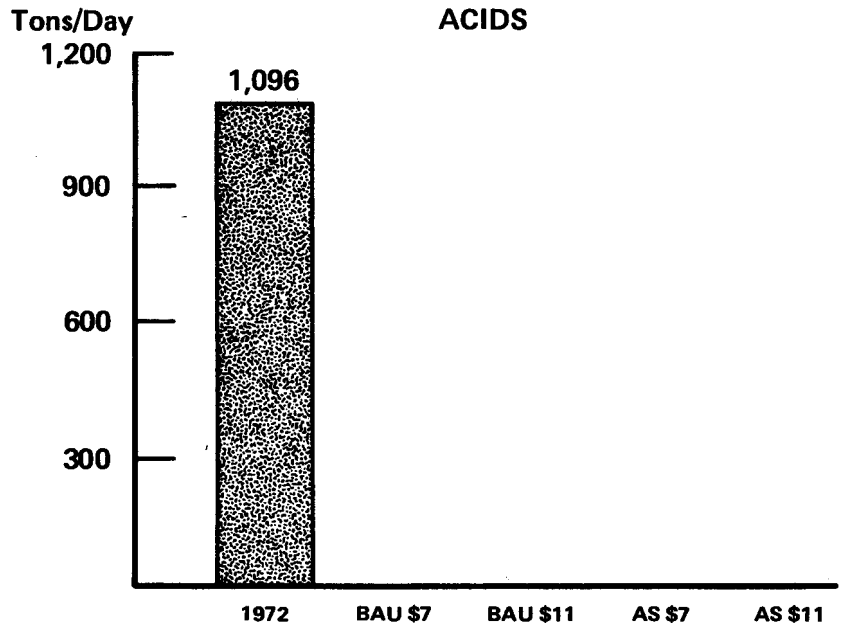

[1]The estimates appear to be extraordinarily low.

[2]Dissolved solids include acids, bases, phosphates, and nitrates.




Source: Project Independence Report, Environmental Quality Analyses, Environmental Protection Agency, 1974, pages 46-49.

# Water Consumption in Energy Conversion and Refining

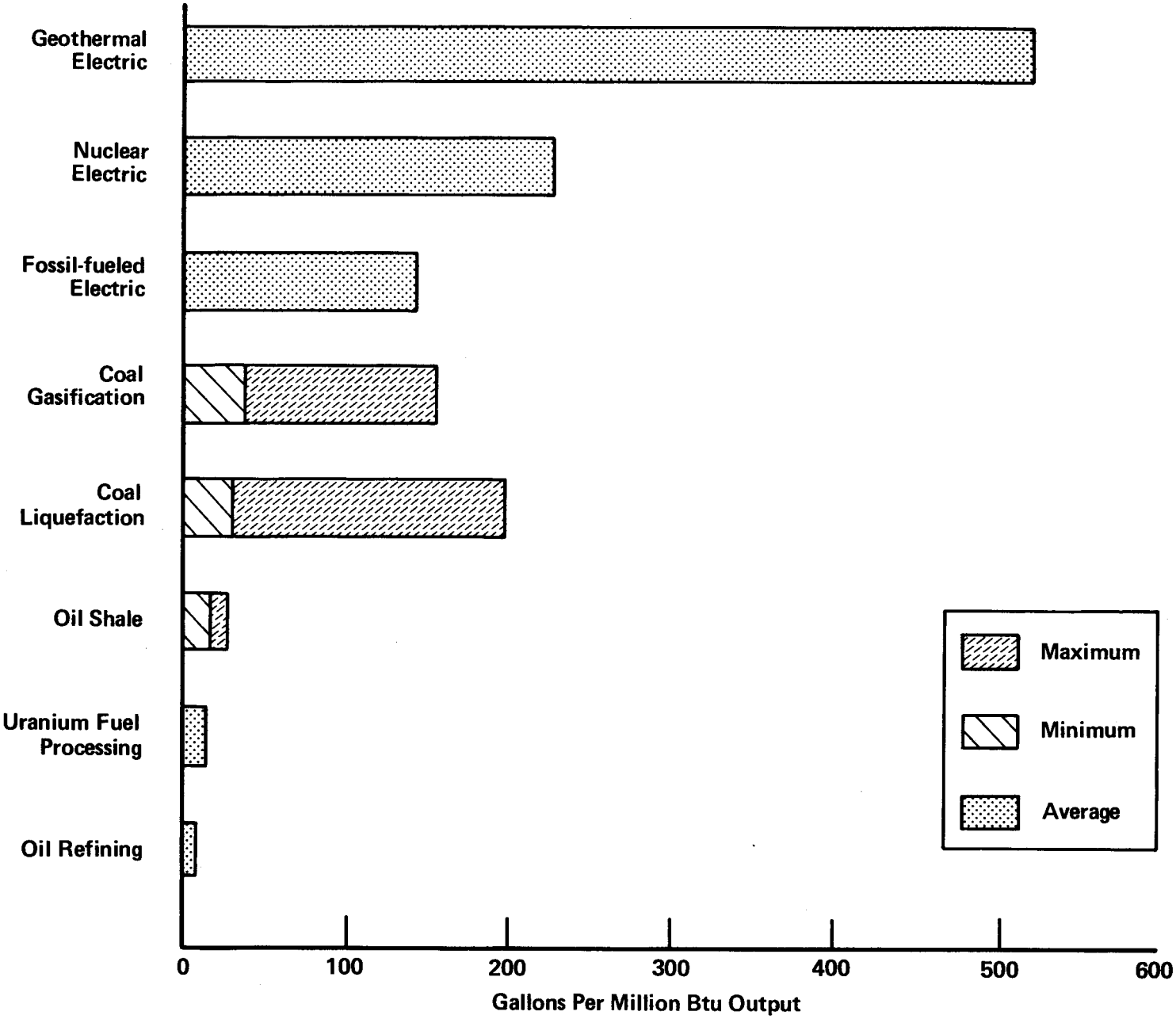
Geothermal electrical generation consumes more than twice the water per million Btu output as nuclear electric and coal liquefaction, the second and third most water-intensive energy conversion and refining processes.

The least water-intensive processes are uranium fuel processing and oil refining.

**Water Consumption in Energy Conversion and Refining**
**(Gallons Per Million Btu Output)**

| PROCESS OR PRODUCT | CONSUMPTIVE USE |
|---|---|
| URANIUM FUEL | 14.3 |
| OIL REFINING | 6.7 |
| PIPELINE GAS FROM COAL: | |
| (A) WATER COOLING (90 Percent Load Factor) | 72-158 |
| (B) PARTIAL AIR COOLING (90 Percent Load Factor) | 37-79 |
| SYNTHETIC OIL FROM COAL | 31-200 |
| ELECTRICAL GENERATION (80 Percent Load Factor): | |
| (A) FOSSIL-FUELED PLANTS | 146 |
| (B) NUCLEAR | 234 |
| (C) GEOTHERMAL | 527 |
| OIL FROM SHALE | 19-29 |

# Water Consumption in Energy Conversion and Refining




Source: U.S. Geological Circular 703, Water Demands for Expanding Energy Development, 1974.

# Glossary

**ACCELERATED SUPPLY STRATEGY**

(Accelerated Development) The Federal Government takes actions to increase the domestic supply of energy including accelerated Federal leasing of the Outer Continental Shelf; opening the Naval Petroleum Reserves to commercial exploration and development; and removing regulatory constraints (See Project Independence Report).

**BREEDER REACTOR**

A nuclear reactor capable of producing more nuclear fuel than it consumes.

**BRITISH TERMAL UNIT (Btu)**

The amount of heat required to raise the temperature of 1 pound of water 1° Fahrenheit under stated conditions of pressure and temperature.

**BUSINESS AS USUAL STRATEGY**

Existing policies continue and only limited new actions are considered (See Project Independence Report).

**CAPACITY**

The maximum power output or load for which a machine, apparatus, station, or system is rated.

**CAPACITY FACTOR**

The ratio of the amount of electricity produced by a plant or system to its maximum theoretical productive capacity.

**COAL GASIFICATION**

The conversion of coal (a solid) to a gas which is suitable for use as a fuel. The gas produced may be either a high-Btu or a low-Btu fuel. High-Btu gas is similar to natural gas and will range in energy content from 900 to 1,000 Btu per cubic foot. Low-Btu gas may range as low as 200 Btu per cubic foot.

**COAL LIQUEFACTION**

(Coal Hydrogenation) The conversion of coal into liquid hydrocarbons and related compounds by hydrogenation.

**COAL SLURRY PIPELINE**

A pipeline that transports coal in pulverized form suspended in water.

**CONSERVATION STRATEGY**

The Federal Government takes actions necessary to reduce demand for energy, particularly petroleum, including perhaps setting of minimum mileage standards for new automobiles, and provision of incentives and standards to increase residential insulation and energy-use efficiency (See Project Independence Report).

**DEMONSTRATED COAL RESERVE BASE**

Measured and indicated in-place quantities of bituminous coal and anthracite located in beds 28 inches or more thick, and subbituminous coal in beds 60 or more inches thick which are located in depths up to 1,000 feet. The demonstrated coal reserve base includes also small quantities of coal located in beds thinner and/or deeper than coal presently mined, for which there is evidence that mining is commercially feasible at this time. The data for lignite include beds 60 inches or thicker that can be surface mined. These are generally located at depths no greater than 120 feet.

In general, the amount of coal that can be recovered from a deposit ranges from 40 to 90 percent of the reserve base.

**FUSION**

The combining of atomic nuclei of very light elements by collision at high speed to form new and heavier elements, resulting in the release of energy.

**HYDROELECTRIC POWER PLANT**

An electric power plant in which the turbine generators are driven by falling water.

**LIGHT-WATER REACTOR (LWR)**

Nuclear reactor in which water is the primary coolant/moderator, with slightly enriched uranium fuel. There are two commercial light-water reactor types—the boiling water reactor (BWR) and the pressurized-water reactor (PWR).

**LOAD FACTOR**

The ratio of the average load supplied during a designated period to the peak of the maximum load occurring in the same period for an electrical system.

**MEGAWATT**

1,000 kilowatts.

**OIL SHALE**

Range of materials containing organic matter (kerogen) that can be converted into crude shale oil, gas, and carbonaceous residue by destructive distillation.

## PARTICULATE MATTER

Solid particles, such as ash, that are released in exhaust gases from the combustion process at fossil-fuel plants.

## PROJECT INDEPENDENCE

A large-scale study initiated by the Federal Government to evaluate the Nation's energy problems and to provide a framework for developing a national energy policy. The main thrust of the report was analysis of the actions necessary to minimize U.S. reliance on energy imports (primary petroleum). Most actions were evaluated in terms of $7 and $11 oil prices existing in the United States. See Business as Usual, Conservation, and Accelerated Supply strategies.

## QUADRILLION

1 million billion; $10^{15}$.

## RESERVES

Identified deposits known to be recoverable with current technology under present economic conditions.

Categories of Reserves

1. Measured reserves. Identified resources from which an energy commodity can be economically extracted with existing technology, and whose location, quality, and quantity are known from geologic evidence supported by engineering evidence.
2. Indicated reserves. Reserves based partly on specific measurements, samples, or production data, and partly from projections for a reasonable distance on geological evidence.
3. Inferred reserves. Reserves based upon broad geologic knowledge for which quantitative measurements are not available. Such reserves are estimated to be recoverable in the future as a result of extensions, revisions of estimates, and deeper drilling in known fields. Indicated and inferred reserves are undifferentiated in this report.

Reserves of coal are sometimes discussed in terms of a different definition. See Demonstrated Coal Reserve Base.

## RESOURCES

Includes reserves as well as materials that have been identified, but cannot now be extracted because of economic or technological limitations, as well as economic or subeconomic materials that have not as yet been discovered.

Recoverable resources are quantities of an an energy commodity that may be reasonably expected to exist in favorable geologic settings, but that have not yet been identified by drilling. Exploration will permit the reclassification of such resources to the reserves category.

GPO 886-552

## SEPARATIVE WORK UNIT (SWU)

A measure of the effort expended in a uranium enrichment plant to separate a quantity of uranium of a given assay into two components, one having a higher percentage of uranium-235 and one having a lower percentage. Separative work is generally expressed in kilogram units. Therefore, a SWU is a kilogram separative work unit.

## SHALE OIL

A liquid similar to conventional crude oil but obtained from oil shale by conversion of organic matter (kerogen) in oil shale.

## THERMAL POLLUTION

A rise in the temperature of water, causing detrimental effects on other uses of the water.

## TOTAL GROSS ENERGY CONSUMPTION

Total energy inputs into the economy, including coal, petroleum, natural gas, and the electricity generated by hydroelectric, nuclear, and geothermal power plants. Gross consumption includes conversion losses by the electric power sector.

## TOTAL NET ENERGY CONSUMPTION

Inputs into the final consuming sectors, i.e., household and commercial, industrial, and transportation, and consisting of direct fuels and electricity distributed from the electric power sector. Conversion losses in the electric sector constitute the difference between net and gross energy.

## TRILLION

1 million million; $10^{12}$.

## URANIUM OXIDE ($U_3O_8$)

(Yellowcake) The international standard for the form in which uranium concentrate is marketed.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.