

# COAL RESERVES IN THE UNITED STATES AND AROUND THE WORLD

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## ABSTRACT

There is an urgent need to examine the role that coal might play in meeting world energy needs during the next 20 years. Oil from the Organization of Petroleum Exporting Countries (OPEC) can no longer be relied upon to provide expanding supplies of energy, even with rapidly rising prices. Neither can nuclear energy be planned on for rapid expansion worldwide until present uncertainties about it are resolved. Yet, the world's energy needs will continue to grow, even with vigorous energy conservation programs and with optimistic rates of expansion in the use of solar energy.

Coal already supplies 25% of the world's energy, its reserves are vast, and it is relatively inexpensive. This study, with the aid of reports from the World Coal Study (WOCOL) examines the needs for coal on a global scale, its availability past and present, and its future prospects.

## INTRODUCTION

Coal, like all fossil fuels, is a carbon-rich substance derived from biomass which has grown in the past- in effect, a form of stored solar energy. Unlike petroleum or natural gas, which are thought to originate in the bacterial

decay of microscopic marine plants and animals, coal is mainly produced from large plants which grew on land or in shallow swamps. Four main stages of coal are usually distinguished, with each corresponding to a particular class, or rank, of coal, determined by their fixed carbon, volatile matter and moisture contents. Further sub-divisions are also made. The four main coals are:

*Lignite:* A brownish-black substance, usually described as "brown coal", with untransformed woody matter embedded in decomposed vegetable material. It is liable to spontaneous combustion in air. A high moisture content causes it to disintegrate on drying and gives a low calorific value.

*Sub-bituminous:* A dull-black, waxy, banded substance, in which most woody matter has been transformed. It is intermediate between lignite and full bituminous coals in calorific value and other properties.

*Bituminous:* A dense, black, banded and jointed substance, which breaks into regular blocks. All the original plant material has been transformed, giving a high calorific

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value. This, plus other properties such as its ignitability and tendency to cake and swell on heating, makes it the most useful and widely produced class of coal.

*Anthracite:* A hard, brittle substance formed under extreme geological conditions. It has a slightly lower calorific value than higher rank bituminous coals, and contains less volatile matter.

## UNITS

Throughout this report, mtce or million metric tons of coal equivalent is used as the standard measure of energy. On an energy basis, 76 mtce per year is equivalent to 1 million barrels per day (mbd) of oil.

A ton of coal equivalent (tce) as used in this report is a metric ton (2205 pounds) of coal with a specific heating value (7000 kcal/kg or 12600 Btu/lb). Because coals vary significantly in heat content more than 1 metric ton of coal is often required to produce the energy content of 1 tce. For example 1 tce is equivalent to 1.4 metric tons of sub-bituminous western United States coal (assuming 9000 Btu/lb).

## COAL GEOLOGY

About 2100 sizable coal deposits have been identified on the earth. Seven of these are giant basins, each containing over 500 Btu of coal, of which five- Kansk-Achinsk, Kuznetsk, Lena, Tunguska and Taymyr- are in the USSR. The others are the Appalachian and Alto-Amazona basins of North and South America. Only the Appalachian and Kuznetsk basins have been exploited on a large scale. Four other basins- Donets and Pechora in the

USSR, Lower Rhine-Westphalia in West Germany, and the Eastern Interior in the USA- contain between 200 and 500 Btu. A further 210 basins have deposits of between 0.5 and 200 Btu. The existence of the larger basins is related to the earth's structural features, and they are concentrated in the belts of continental platforms. Smaller basins are more unevenly distributed, and many have probably not yet been discovered.

## THE NEED FOR COAL

The world has reached the end of an era in its energy history. Increased supplies of oil, which have been the basis for economic growth in the past few decades, are not expected to be available in the future. The development of a new energy basis for continued economic growth has therefore become an urgent necessity. Building a bridge to the energy sources and supply systems of the next century- whatever they turn out to be- is of crucial importance.

In the industrialized countries coal can become the principal fuel for economic growth and the major replacement for oil in many uses. Coal may also provide the only way for many of the less developed countries to obtain the fuel needed for electric power and industrial development, and to reduce their dependence upon oil imports.

Increased use of coal will require large investments, but no greater than those required for other fuels such as oil, gas, and nuclear energy. Countries now heavily dependent upon oil must build coal-using facilities on a large scale before they can use the coal they will need. Power stations, coal ports, railways, and handling facilities take a long time to plan and build. So do

mines and export terminals. Unless decisions are made to build them soon, these facilities will not be ready by the time when this study indicates that they will be acutely needed. It is necessary for governments and industry to act cooperatively so that the required investment decisions are made promptly.

Unlike oil, the reserve base for coal is sufficiently great to support large increases in production for a long time into the future. Moreover, the technology for its safe and environmentally acceptable production, transport, and use is proved and already widely applied in most areas.

Coal is not in competition with conservation, nuclear or solar energy, or other sources as the sole solution to the world's energy problems. All these will be required if the energy needed is to be supplied. The world, however, needs an incremental energy source as nearly like oil as possible, but with the vital difference that it will be obtainable in increasing amounts until well into the next century. Ideally, and if it is to fill the role played by oil over the past decades, it should be versatile in application, easily transported and stored, and reasonably priced. The technology for using it should be mature and generally available so that it can be brought into use rapidly, widely, and safely. It should be capable of satisfying strict environmental standards with presently available technology and at a cost competitive with other fuels. It should be obtainable in large quantities and for long enough to justify the investments required to bring it into widespread use. Only coal becomes close to meeting these specifications.

## WORLD COAL PRODUCTION

Three countries- the United States, the Soviet Union, and the People's Republic of China- were responsible for nearly 60% of the total coal produced in the world in 1977. The next six largest producers, Poland, the Federal Republic of Germany, the United Kingdom, Australia, the Republic of South Africa, and India, accounted for a further 25%. In 1977 the United States accounted for 50% of the total production outside the centrally planned economy countries. Production in the developing countries ( is similarly concentrated, with India being by far the largest coal producer and consumer. See Table 1-1. Source: World Energy Conference and WOCOL Country Reports.

**Table 1-1** World Coal Production for Major Coal-Producing Countries Actual and Projected- 1977 and 2000 (mtce/yr)

Country	1977	2000
Australia	76	326
Canada	23	159
People's Republic of China	373	1450
Federal Republic of Germany	120	150
India	72	285
Poland	167	313
Republic of South Africa	73	228
United Kingdom	108	162
United States	560	1883
Soviet Union	510	1100
Other countries	368	724
Total World	2450	6780

## **PROJECTING COAL REQUIREMENTS**

The analysis of future coal requirements is built upon detailed country studies conducted by WOCOL teams. The teams developed two reference cases to project their expected range of future coal demand. Case A considers a moderate increase in coal demand to year 2000, whereas Case B assumes a high increase in coal demand, one which would increase world coal supply, trade, and use to what now appear to be close to the feasible upper limits.

Each country team formulated its estimates of moderate and high increases in coal use within the general economic, technological and political environment expected within its country. The studies were based on readily available and detailed national energy studies modified to reflect the specific WOCOL focus on projecting a range of future coal requirements.

Projections of total coal use were developed by market sector in each country. Teams also provided estimates of indigenous coal production and the coal imports which might be required. The feasibility of satisfying coal import requirements was assessed by matching them against the estimates of coal export potential made by the major coal-producing countries.

## **COAL USE BY MARKET SECTOR**

The estimates of total coal use in Cases A and B were developed through a detailed analyses by market sector including electricity, metallurgical, industry, residential/commercial, and synthetic fuel within each country.

The major coal use in the year 2000, as today, is projected to be in electricity generation, which consumes more than 60% of the total coal. Estimates of coal requirements in the electric market are strongly influenced by assumptions about rates of growth of electricity demand and the expansion of nuclear power, as well as the replacement rate of existing oil-fired capacity. The WOCOL analysis indicates that, even under the moderate electricity growth assumptions of Case A coal-fired electric capacity in the Organization for Economic Cooperation and Development (OECD) will need to more than double by year 2000. The following are the countries included in the OECD: Canada, United States, Denmark, Finland, France, Federal Republic of Germany, Italy, Netherlands, Sweden, United Kingdom, Other Western Europe, Japan, and Australia.

Coal for metallurgical purposes is the second largest market for coal today in the OECD, accounting for about 250 mtce/year, or 25% of total coal use. The WOCOL projections show a moderate increase to 330-375 mtce/year by the end of the century. However, the metallurgical coal share of the total coal market is projected to fall to about 15% of total coal use by year 2000.

The use of coal in industry has declined rapidly over the past two decades and now accounts for only 90 mtce, or 9% of total OECD coal use. This trend is expected to be reversed. In our projections, industrial coal use in the OECD countries expands by two to four times by year 2000. The major expansion is expected to increase 5 - 7% a year after 1985. Industries where coal use is expected to increase significantly

include cement, chemicals, petroleum refining and paper.

A substantial new market for coal as feed stock for synthetic oil and gas plants could develop in the 1990s. This appears to be particularly likely in the United States.

Coal has nearly disappeared as a fuel for homes and commercial facilities in the OECD countries, with the use in 1977 being less than 50 mtce. Although WOCOL country studies suggest that the total residential/ commercial use of coal may remain insignificant during this century, there are in some countries indications of a revival of interest in coal for use in homes and office buildings. Projections for the United Kingdom, for example, indicate that such coal use could grow from 10 mtce in 1985 to 15-21 mtce by the year 2000. Substantial growth in the use of coal for fuel in district heating plants is also projected in some countries, for example in Denmark.

## CONCLUSIONS

It is now widely agreed that the availability of oil in international trade is likely to diminish over the next two decades. Vigorous conservation, the development and rapid implementation of programs for nuclear power, natural gas, unconventional sources of oil and gas, solar energy, other renewable sources, and new technologies will not be sufficient to meet the growing needs of the world. A massive effort to expand facilities for the production, transport, and use of coal is urgently required to provide for even moderate economic growth in the world between now and the year 2000. Without such increases in coal, the outlook is bleak.

The major conclusions after the WOCOL study are as follows:

1. Coal is capable of supplying a high proportion of future energy needs. It now supplies more than 25% of the world's energy. Economically recoverable reserves are very large—many times those of oil and gas— and capable of meeting increasing demands well into the future.
  2. Coal will have to supply between one-half and two-thirds of the additional energy needed by the world during the next 20 years. To achieve this goal, world coal production will have to increase 2.5 to 3 times, and the world trade in steam coal will have to grow 10 to 15 times above 1979 levels.
  3. Coal is already competitive in many locations for the generation of electricity and in many industrial and other uses. It will extend further into these and other markets as oil prices rise.
  4. Coal can be mined, moved, and used in most areas in ways that conform to high standards of health, safety, and environmental protection by the application of available technology and without unacceptable increases in cost. The present knowledge of possible carbon dioxide effects on climate does not justify delaying the expansion of coal use.
- Coal can provide the principal part of the additional energy needs of the next two decades. In filling this role it will act both as a bridge to the energy

systems of the future and as a foundation for the continued part that coal will play in the next century. A recognition of the urgent need for coal and determined actions to make it available in time will ensure that the world will continue to obtain the energy it requires for its economic growth and development.

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