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EVALUATION OF FUELS

LONG-TERM FACTORS AND CONSIDERATIONS

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EVALUATION OF FUELS

Long-Term Factors and Considerations*

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ABSTRACT

Long-term trends and factors influence the selection of fuels for future industrial use. It appears that the factors that retarded the growth in industrial use of coal, while use of other fuels was rising, are changing and that coal will have a potentially greater future growth. In recent decades, natural gas has been the fastest growing of the major fuels in residential, commercial, and industrial uses. New discoveries of natural gas, however, have not been sufficient to sustain future growth of natural gas use at its present rate. As a result, gas suppliers are finding it necessary to revise their expansion plans. Evidence indicates that the future growth in the use of natural gas, especially for industrial and electric utility purposes, may be restricted. Such restrictions are unlikely to affect current use but may have considerable impact on the choice of fuels for future use.

At this Industrial Coal Conference and ever since the first conference was held in 1928, numerous papers have been devoted to the many aspects of fuel evaluation. During this time methods and procedures for evaluating particular fuels and for comparing the various fuels and their sources have been well developed. For an economist and mining engineer like me to attempt to discuss the evaluation or selection of a fuel for a given plant or installation would be inappropriate, at best. But there are certain long-term factors and considerations aside from day-to-day use that have had a tremendous impact on the patterns of fuel utilization in the past, and new factors are emerging that will very

* Presented at the Industrial Coal Conference, Purdue University, Lafayette, Indiana, October 8-9, 1969.

likely have an equal or even greater impact in the future. It is these trends and some of their implications that I wish to discuss this afternoon.

One of the major factors in the progress of our nation in the past several decades has been the growth in energy use. In only 10 years—from 1957 to 1967—the total annual consumption of energy in the United States increased 51.4 percent, growing from 38,897 trillion Btu's to 58,873 trillion Btu's. Of this total, 95.9 percent was provided by the fossil fuels (coal, anthracite, natural gas, and petroleum), with the remainder coming from hydro-power and nuclear energy. While we all recognize, by the number of automobiles on our streets and highways and the airplanes in the skies overhead, that the use of energy in transportation has increased immensely, energy consumption for other less obvious uses has risen even more. From 1957 to 1967, while use of fuel in transportation increased 41.5 percent, fuel use for other purposes increased about 58 percent.

The greatest growth in non-transportation use of fuel, 124 percent, took place in generation of electric power, which was used for a multitude of purposes, both industrial and non-industrial. The direct industrial consumption of fuels, excluding that for coke manufacture and that used by utilities in generating electric power, rose 51.7 percent.

The growth in fuel use has been accompanied by a marked shift in the relative percentages of total energy provided by each of the fuels. Coal provided the largest share of total energy until 1950, when petroleum took the lead. More recently, natural gas has been displacing coal in many of the non-transportation uses of energy.

The special suitability of liquid fuel for use in automotive vehicles, railroad locomotives, and aircraft has enabled petroleum, with virtually no competition, to take over the transportation market, which currently consumes almost 24 percent of all fuel energy used.

In most non-transportation uses the various fuels are, to a large degree, equally able to provide energy and are often interchangeable. Of course, only coal can be used for the manufacture of coke, and natural gas is superior in certain industrial applications where cleanliness and precise temperature control are especially important. In residential heating, cleanliness and convenience are important factors.

Trends in the use of the major fuels for non-transportation uses are shown in Figure 1. While the use of bituminous coal, natural gas, and petroleum all have increased, the increase in use of natural gas is particularly notable. The expansion of the network of pipelines, especially since World War II, has made natural gas available throughout much of the nation. In addition, well-head prices have been held at an artificially low level by governmental regulation and differential pricing for gas sold for various uses has been taking place at the point of destination, a combination that has made gas available in many locations at prices that are significantly lower than those of other fuels.

The same factors are reflected in Figure 2, which shows industrial use of fuels, exclusive of electric power and coke production. Here, again,

GROWTH IN NON-TRANSPORTATION
FUEL USE
U.S., 1957 AND 1967

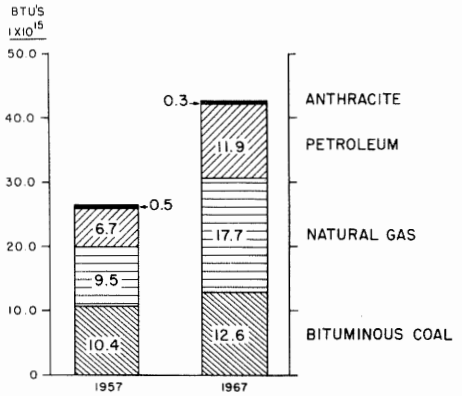
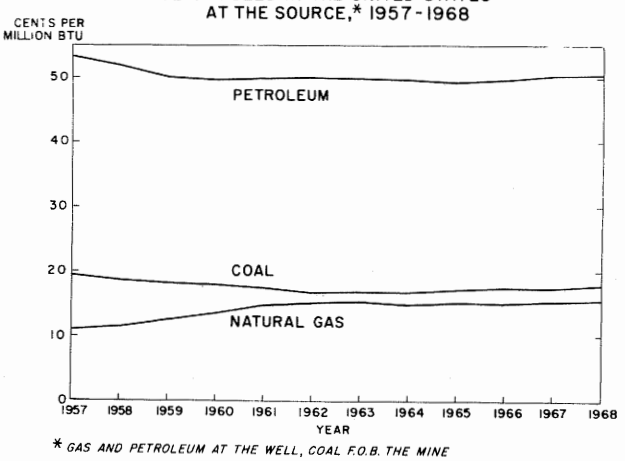


Figure 1

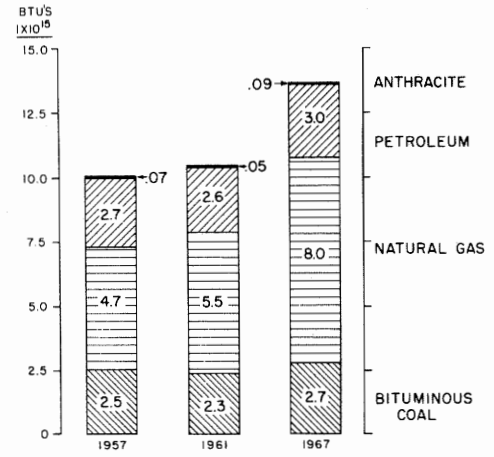
VALUE OF FUELS IN THE UNITED STATES
AT THE SOURCE,* 1957-1968



* GAS AND PETROLEUM AT THE WELL, COAL F.O.B. THE MINE

Figure 3

FUEL ENERGY CONSUMED FOR INDUSTRIAL USES*
U.S., 1957, 1961, 1967



* EXCLUDES ELECTRIC UTILITIES AND COKE

Figure 2

NATURAL GAS TRENDS, 1957-1967

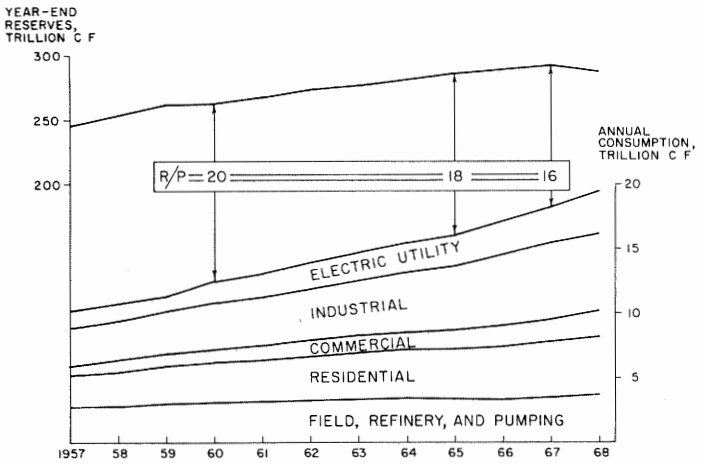


Figure 4

the principal growth has been in the use of natural gas. Because natural gas generally has a lower sulfur content than coal and much of the petroleum, the position of natural gas has been further improved during recent months by restrictions placed on sulfur dioxide emission from fuel-burning plants. Sulfur restrictions and the procedures being developed to control sulfur dioxide emission from coal-burning plants will be discussed in a number of papers during this conference.

In the light of past experience, it seems logical to ask whether the trends that have carried natural gas from a position of providing only 47.0 percent of total industrial fuel energy in 1957 to 58.0 percent in 1967 (fig. 2) will continue unabated. Is coal as an industrial fuel to become a thing of the past? Factors that first became evident about 1960 now point increasingly to a definite "no" as the answer to both of these questions.

GEOGRAPHIC LOCATION

Geographic location is one factor that significantly affects the competitive positions of the specific fuels, and within the contiguous states of the nation none of the three major fuels is likely to be completely displaced by the others. In the southwestern part of the nation, where most of the known gas and oil reserves occur, the consumption of coal is almost negligible. In the areas east of the Mississippi River a more favorable situation exists for coal, since gas and oil from the Southwest must move long distances to reach the region. About 95 percent of the coal production, 90 percent of the utility coal consumption, and 91 percent of the general industrial consumption of coal occur in these areas.

More than a third of the industrial coal is consumed in four states—Illinois, Indiana, Michigan, and Wisconsin. A recent study by the U. S. Bureau of Mines showed that from 1960 to 1965 the total industrial use of coal (other than for coke and utilities) in these four states increased 22.8 percent, compared to an average gain of 16.0 percent for the entire area east of the Mississippi River. The national increase, however, was reduced to only 10.7 percent by losses in consumption west of the Mississippi.

It is unlikely that coal will attain much significance in the Southwest for a long time to come. The four states composing the West South-Central Region (Texas, Oklahoma, Louisiana, and Arkansas) possess about 80 percent of the natural gas reserves and provide 79 percent of its annual production. One-third of the general industrial use of natural gas for fuel occurs in these states, and, if the field and raw material uses of natural gas by industry are added, 46.8 percent of the total industrial consumption occurs there.

PRICE TRENDS

Another factor that has influenced and will continue to affect patterns of fuel use is price trends. These will have an especially important impact on

future patterns of industrial fuel consumption. Figure 3 shows the reported national average value of petroleum, coal, and natural gas at the point of production. A convergence in the cost of coal and natural gas during the decade is apparent. With the decline in the cost of coal and the increase in the cost of gas, the indicated values of these two fuels do not differ greatly at the source. Both are considerably cheaper in value per Btu than petroleum.

The average reported costs of gas shown in Figure 3 are lower than those at which new supplies currently are being contracted. Total purchases of natural gas, which establish the average price for any given year, include quantities of gas bought under contracts dated as much as 20 years earlier, when costs were much lower. As these lower-price contracts are replaced, average costs will automatically increase. Thus, natural gas prices will continue to rise in the future, even if regulation of new purchase prices continues. As a matter of fact, however, it is apparent that some relaxation of regulation must occur if the nation is not soon to be faced with shortages of gas.

Improved technology in pipeline transmission and gas storage may continue for a time to hold delivered costs of gas near their present level. Increased field prices, however, will inevitably be reflected in the price charged to distribution utilities by pipeline transmission companies and, in turn, in the price the consumer must pay the distributor.

RESOURCES

At least equally as important to the industrial fuel consumer as the price of gas will be the availability and assured supply of fuel. Figure 4 shows the relation of annual consumption of natural gas to known reserves. Until 1968, the known reserves were increasing, but the ratio of reserves to production (R/P) was steadily decreasing. From 20 in 1960, the R/P ratio had declined to 18 in 1965 and to 16 in 1967 (fig. 4), as more and more gas was used without offsetting increases in reserves.

In 1968, the total reserves declined by 5.56 trillion cubic feet when, for the first time in history, annual production exceeded new additions to the reserves. Recent estimates indicate that the present R/P ratio is only 14.5.

There is no way of determining at the present time how low the R/P can be permitted to fall without restricting the industry's ability to supply the gas needed to meet new demands. Several studies have indicated, however, that without a significant improvement in the rate of new discoveries productive capability is likely to peak in the mid-1970s at a level of about 25 trillion cubic feet per year. In 1968, 19.4 trillion cubic feet of gas was produced.

The effects of these reserve trends are already becoming apparent in the curtailment or postponement of expansion plans by gas utilities. A recent newspaper article discussed the problems of a Chicago-based gas utility in acquiring additional gas supplies for planned expansion of its operation.*

* Chicago Daily News, December 1968.

More recently a magazine article pointed out the inability of other distributors to obtain additional gas, even for their near-future needs.* Transmission lines are unable to fill requests from distributors because they themselves cannot obtain the necessary additional supplies.

FUTURE OF FUEL CONSUMPTION

In the face of increasing demand and declining availability, what is likely to happen to gas consumption? The patterns in Figure 4 can, perhaps, provide a clue. The uses for natural gas are arranged, from upper to lower in the order in which satisfactory substitution of other fuels probably can most readily be made. In the upper part of the figure are electric utility and industrial uses, which together account for about 60 percent of the total natural gas consumption in the United States. In the event of an insufficient supply of gas, the curtailment is likely to be felt here first. However, in general, these are also the uses in which substitution of other fuels would normally involve the least loss of efficiency. The least likely targets for substitution, shown at the bottom of the figure, are oil and gas industry field uses and residential use.

Government agencies have, for years, exercised authority over gas prices and rates from the well head to the burner. Of late there is evidence that both federal and state agencies will attempt to influence, if not to directly control, the end uses to which gas may be put.

The Public Service Commission of New York has intervened in a number of cases involving applications for approval of additional supplies of natural gas for industrial and electric utility use.* The Commission's position is that if, indeed, there is a shortage of gas as has been claimed, it should not be used for "inferior" purposes but, rather, for higher uses, especially residential.

The Federal Power Commission has continued to consider each case individually, approving some applications for gas for boiler or industrial use and denying others. It does not concede that it is yet appropriate to begin rationing gas to the various consuming sectors of the market. The Commission recognizes, however, that the uses of the available gas supplies must be examined if control over the end use is to be avoided.†

Air pollution control regulations, which limit the use of other fuels, make the decisions of gas regulatory agencies even more difficult. The burning of gas beneath boilers conceivably may be shifted from the category of a "low order" use to a priority use so that air pollution restrictions can be met.

A temporary postponement of the impending gas supply shortage appears possible through some relaxation of well-head price restrictions. Increased prices would have an effect on both the supply and demand of natural gas.

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* Oil and Gas Journal, July 21, 1969, page 30.

† Ibid., page 31.

Presumably, such an increase would provide greater incentive to search for and discover new supplies of gas. It would, at the same time, make gas prices less attractive to marginal consumers or potential consumers and thus reduce the demand. Some utility and industrial plants would be led to consider other fuels to fill their energy requirements. It is obvious, however, that while such an approach might speed up the rate of gas discovery, the ultimate amount of gas available to be discovered would not be increased.

SUMMARY

Despite the decline in its relative position, coal continues to supply an important share of the demand for industrial energy. Furthermore, increasing evidence indicates that, as the result of trends in prices and fuel availability, coal's position will likely be strengthened in the future. While these trends may not be of concern in terms of current programs, they will be of vital significance in the consideration and design of future plants and facilities.

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* Out of print