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Energy for the Future

Most of the energy needs of the United States are met by fossil fuels. In 1960, petroleum, natural gas, and related products supplied 71.8 percent of the energy consumed, while coal and lignite furnished 24.5 percent. Nuclear energy accounted for 0.1 percent.*

This pattern will change. The sudden emergence of competitive nuclear energy has been noted [see, for example, *Science* **152**, 703 (1966)]. Not so evident are trends in the availability and use of petroleum and related products. At one time the United States was a low-cost producer and exporter of petroleum. Today we are not competitive, and we import more than 20 percent of our needs, at an annual cost approaching \$2 billion. Proved reserves of crude oil of 30×10^9 barrels are adequate for the next decade, and more oil will be found. However, the cost of finding oil is increasing, and the United States is no longer an attractive area for petroleum exploration. The most important petroleum discoveries are being made in the Middle East and Africa.

There is controversy over estimates of the amounts of oil likely to be found in the United States, despite the fact that 1.9 billion feet of exploratory holes have been drilled. Hubbert† has shown that present-day drilling is discovering less oil per foot of drilling than was found a generation ago. He estimates that, during the period 1930–35, each foot of hole drilled led to discovery of an average of 160 barrels of oil. He estimates that, during the period 1960–65, 39 barrels of oil were found per foot drilled. This comparison includes an estimate of the amount of oil to be added by development drilling and extensions.

Recently Robert O. Anderson, chairman of Atlantic Richfield Company, implicitly confirmed the view that prospects are not good for discovering petroleum in the United States. He warned that, by 1976, imports of petroleum could account for a third of total U.S. consumption, at a cost of \$4 to \$5 billion annually. This would aggravate an already serious problem in balance of payments and would place us at the mercy of Middle Eastern and other foreign suppliers.

Fortunately there are alternatives. The oil-shale deposits of the western United States could be exploited to produce more than 10^{12} barrels of oil. Hydrogenation of coal also could supply enormous quantities of liquid fuels. Government and industry have not made great efforts to develop these alternative sources. Estimated expenditures for energy research and development during 1963* for government and industry, respectively, were (in millions of dollars): coal, 11 and 11; oil and gas, 40 and 336; nuclear fission, 210 and 90.

Research and development work sponsored by the Office of Coal Research of the Department of the Interior looks promising. Notable are two developments being conducted by Consolidation Coal, now a division of Continental Oil Company. One involves solvent extraction of coal followed by hydrogenation to produce liquid fuels similar to gasoline. A second development is an improved process for synthesizing methane from lignite.

This nation has been slow to respond to a deteriorating position in petroleum exploration. There should be substantially increased effort to develop substitute supplies through research, development, and economic incentives.—PHILIP H. ABELSON

* "Energy R & D and National Progress" (Government Printing Office, Washington, D.C., 1965). † M. King Hubbert, *West Texas Geol. Soc. Pub. No. 66-53* (1966).