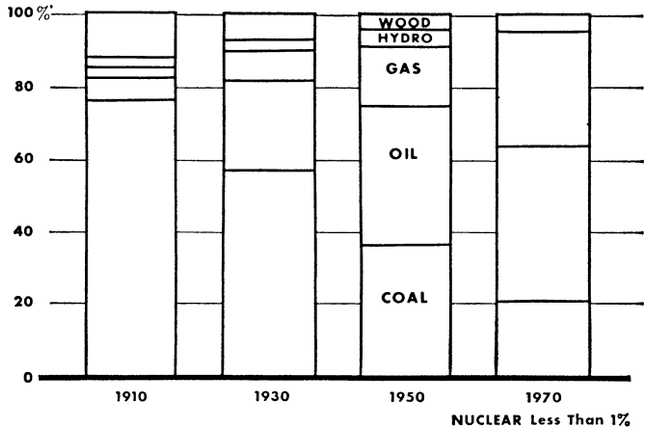
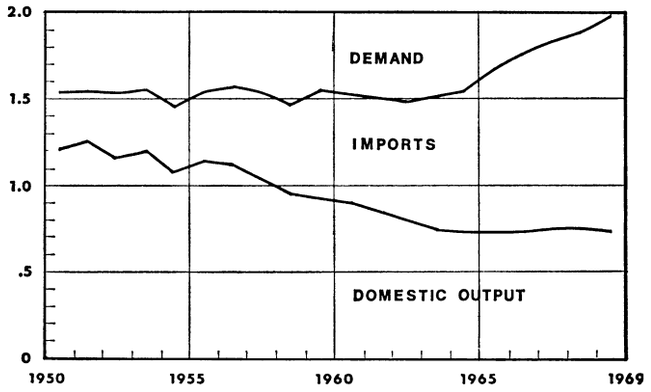
The competitive comeback of coal

New technologies could place coal once again among prime energy sources





Interior

Coal has declined in importance among fuels, but domestic shortages of other fuels could create a reversal.

by Richard H. Gilluly

During and immediately following World War II, the coal industry boomed. Coal then was still often used for home heating. It also powered the locomotives that hauled the nation's war materiel, as well as the electric power plants which fed energy to war industries. The United States' coal boom was not the only one then. During the war, Germany, after it lost its oil supplies in the Near East, used "braun" coal, similar to the lignite in Western states, to make petroleum-type products.

In the United States, the coal industry hit its peak in 1947, when production reached 630 million tons. After that, production declined steadily as diesel-electric locomotives replaced the old steam-powered ones, as natural gas and fuel oil replaced coal for home heating and as petroleum replaced coal tar as the basic source of organic chemicals for industry.

The coal industry remained moribund until the late 1960's, when a revival began. Preliminary statistics for 1970 indicate that coal production was about 590 million tons, the third highest yearly figure in the nation's history.

The revival is clearly being generated by the nation's energy crisis (SN: 11/14/70, p. 379). Natural gas is in short supply, either because reserves are truly diminishing or because the industry is holding back production for higher prices. The cost of residual fuel oil has escalated as it becomes more difficult to get this fuel from foreign sources. And the nation's supply of new hydroelectric sites is about used up. By far the largest market for coal is, of course, the electric power industry, which in recent years has used all these sources of energy.

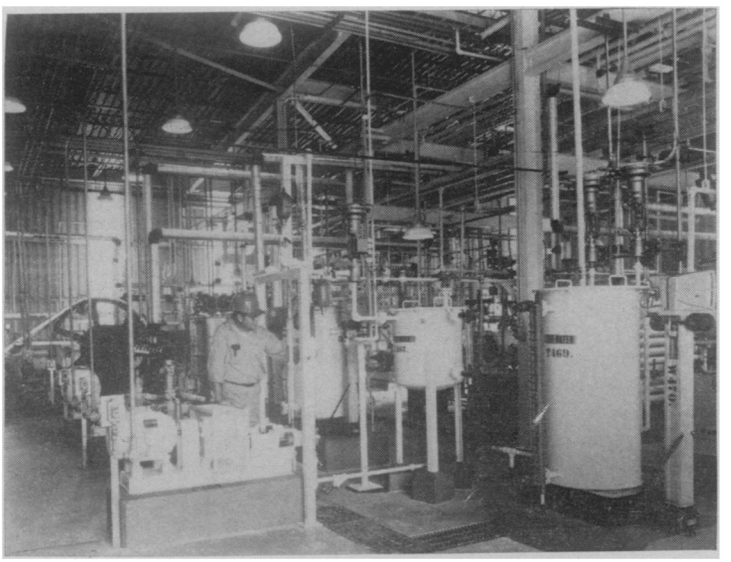
Whether the coal boom will continue and for how long depends on a number of things. Electric power needs are doubling every 10 years, and unless a wholly new philosophy of energy use patterns (or a new philosophy of progress, now measured by an energy-paced ever-increasing gross national product) should evolve, there is little likelihood of a slowdown. Nuclear energy still supplies only a small portion of the market. It may increase greatly, especially if fast breeder reactors or fusion power are commercially developed. But there are indications that, because of rapidly rising costs in nuclear power—partly covered by a subsidy from the Atomic Energy Commission which opponents of nuclear power claim gives this energy source an unfair advantage—that energy source may not be the future supplier of energy it was once envisioned to be, at least until new technologies are developed.

But coal currently has disadvantages, too. The prime ones are those connected with environmental pollution. Sulfur oxides from power plant stacks clearly are the greatest single liability of coal (SN: 8/29/70, p. 187); much of the coal now mined in the United States has a very-high sulfur content. Other fossil fuels—natural gas and oil—possess this liability to a lesser degree or not at all. But it is these fuels that are in short supply.

Advocates of coal claim it is the logical alternative. They add that technologies are now available, at least in the pilot plant stage, to eliminate the liabilities. Perhaps the most promising such technology is gasification of coal: conversion to sulfur-free producer gas for power plants, or to methane for pipeline gas for use as a natural gas substitute in home heating and for other purposes.

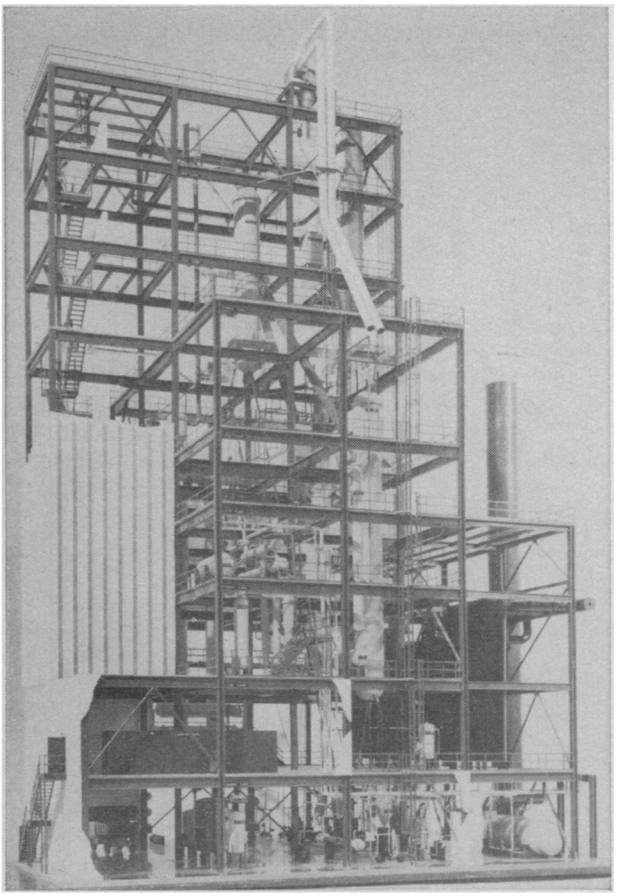
The basic chemistry of conversion of coal to a gaseous fuel has long been known. Coal gas was a commonly used fuel in many homes and industries until it became possible, in the 1930's, to transmit large amounts of natural gas cheaply in welded steel pipes of large diameter. The old coal gas was produced by destructive distillation, the heating of sized coal in a retort to produce a mixture of flammable gases. New processes are essentially the same, except that they use pulverized coal in continuous processes, and extremely high temperatures and pressures. They offer a potential for low-cost production because of the economies of size.

There are a number of possible variations.



Photos: National Coal Assn.

Coal to gasoline: FMC Corporation's COED pilot plant.



Lignite gasification: CO_2-acceptor plant in South Dakota.

A Bureau of Mines process, for example, reacts coal with steam and oxygen in a fluidized bed to produce a mixture of methane, hydrogen, carbon monoxide, hydrogen sulfide and carbon dioxide. The CO_2 and H_2S are removed (elemental sulfur can easily be obtained from the H_2S, thus removing the coal's sulfur from the final product) and the CO and H_2 are reacted to form more methane. The bureau estimates the selling cost of the final gaseous product—mostly methane, the major component of natural gas—would be about 54 cents per 1,000 cubic feet, a cost that may become competitive if natural gas costs continue to rise.

The Office of Coal Research, another Interior Department agency, is supporting three pilot plant projects for gasification of coal. The Hy-Gas project, built in Chicago under contract to OCR by the Institute of Gas Technology, will use tall reactor towers, fluidized beds and high temperatures and pressures in a two-stage process that reacts steam with the coal's carbon to make methane. Carbon monoxide and hydrogen are also produced and are used to power a generator that makes electricity for electrolysis of water into hydrogen and oxygen for one stage of the conversion process.

A CO_2-acceptor process will be used in a Rapid City, S. Dak., plant operated by Consolidation Coal Co., and a third process, similar to Hy-Gas, will be tried near Homer City, Pa. These latter two processes also end up with CO and H_2, which are reacted to form methane, or pipeline gas.

A major possibility for the Bureau of Mines and Homer City plants, however, is to produce a lower-B.t.u. (British thermal unit) producer gas by using air instead of oxygen. The final product thus would end up diluted with nitrogen, but it might be suitable for burning in either gas turbine or steam-electric power plants. OCR official Neal Cochran suggests the cost of such a fuel might be in the neighborhood of 35 to 55 cents per million B.t.u.'s. Since New York utilities are paying as much as 65 cents to $1.00 for a million B.t.u.'s in low-sulfur fuel oil, the producer gas could be attractive in such areas.

Gasification may have the largest potential for the coal industry, mainly because gas currently is the fastest growing energy source, with about a 7 percent national growth rate, compared with a 3 percent rate for all forms of energy. But there are a number of other possibilities for conversion of coal to clean and useful energy sources of the future.

A solvent process promises to use anthracene solvents, obtained from the coal itself, to allow removal of ash and sulfur from coal. The final product may have an ash content of 0.1 percent and a sulfur content as low as 0.2 percent. The process considerably concentrates the heating value of coal. Bituminous coal yields 25 million B.t.u.'s per ton, and lignite 12 million to 14 million. But the solvent process gives about 32 million.

Given the high costs of transportation (Commonwealth Edison Co. of Chicago is paying around $8 a ton to transport low-B.t.u. low-sulfur sub-bituminous coal from Montana to Chicago), this concentration of energy could be important. Hydrogen is chemically added to the fuel in the relatively low-temperature, low-pressure process to create a final fuel that can be used in either liquid or solid forms.

Another possibility is for a more extensive hydrogenation and removal of impurities to make synthetic high-grade fuels, such as gasoline, from coal, as the Germans did during World War II. OCR contractors operate a pilot plant in Cresap, W. Va., for such processes. Soon to be tried there is a direct hydrogenation process bypassing an earlier step that required extraction of essential substances from coal first.

This and processes developed by various industrial firms promise soon to get gasoline-from-coal costs to within competitive range of gasoline-from-petroleum costs, report G. Alex Mills and Harry R. Johnson of the Bureau of Mines and Harry Perry of the Library of Congress in an article in the January ENVIRONMENTAL SCIENCE AND TECHNOLOGY.

OCR's Cochran points out that the vast Alaska North Slope oil discovery may slow commercial development of gasoline from coal. However, he agrees with them that declining reserves of domestic petroleum relative to needs will make commercial coal-to-gasoline processes inevitable. Cochran believes that because of the greater reserves of

. . . coal

coal and more advanced technology, coal will be developed before its competitor, oil shale.

Another possibility for making coal environmentally more palatable is to use only the low-sulfur coals of Appalachia and the West. Most of these coals have less than one percent sulfur; the Western coals average about 0.6 percent. The problem is that these coals are either hard to mine because of their depth or are remote from markets for electric power. Many of the Appalachian low-sulfur coals lie in seams 1,000 feet deep, accessible only to underground mining, which is more expensive than strip mining. The Western coals are found in places such as North Dakota, Montana and Wyoming, far from population centers.

Some of the Western coal, however, is already being shipped as far east as Chicago, and Western coal advocates claim there are better ways of shipping it than by rail. They propose a national extra- or ultra-high voltage grid system, which would establish major regional interconnections throughout the nation (SN: 8/29/70, p. 187) allowing the coal, in effect, to be shipped by wire, from power plants built right on the coal fields. Although in absolute terms this is a more expensive way of shipping energy than by rail (or any other way, for that matter) these advocates say other benefits provided by the lines would bring the costs down substantially. The main benefit is that regional interchanges of power would take advantage of diversity in peak loads.

A study by the Interior Department several years ago indicated they may be right, but utilities showed little interest in the study, and now it needs updating. An environmental advantage of such a system would be removal of power plants from congested areas.

One environmental impact of coal that would remain unchanged no matter how the coal is converted into useful energy is the creation of spoil banks, ugly mounds of overburden and accompanying gullies from strip mining. This technique is gaining an increasing share of coal production because of its economies.

The spoil banks not only deface the land and make it unsuitable for agricultural use but also contribute to secondary problems such as acid-mine drainage into waterways. The Interior Department has proposed national standards for strip-mine reclamation, but legislation has been thwarted in Congress. Thus there are only state laws (and Federal regulations for mining on Federal lands). They generally are weak or not yet well enforced.

Meaningful reclamation would add a considerable cost to coal, thus altering the economics of its competive position. But such environmental considerations are altering the competitive position of other energy sources, too, and there appears to be little doubt that coal, of which the nation has about 128 billion tons of strippable reserves, should have an important future role. A major problem today is that very little Federal or corporate money is being spent on research, development and demonstration of coal-using processes. OCR's budget this year is $18 million. Badly needed is a Federal energy policy that would establish priorities and allocate the R&D funds accordingly. The nation has put most of its energy eggs in the atomic basket —if Federal funding is the measure— and, say coal's advocates, the time has come to give coal its fair share, for the benefit of the energy consumer and the environment. □

One liability of coal is evident in strip-mining areas: The ruined earth.