THE ENERGY CRISIS

Although energy is not a "thing," it has assumed, through its development into a crisis, the attributes of a "thing." It can now be "seen" (brownouts and blackouts), smelt and tasted (pollution), and felt (in the pocketbook). To tackle "The Crisis," the Winter Annual Meeting brought together a group of nationally known engineers, financiers, scientists, government officials, and concerned citizens to knead the problem into a shape that could be handled, dealt with, and perhaps solved, at least for the short run.

Defining the Crisis

A Scientist's View. David C. White, Ford Professor of Engineering, Massachusetts Institute of Technology: The nation's widely publicized "energy crisis" is usually expressed in terms of two major concurrent symptoms: first, the enormous volumes of energy consumed at an exponential growth rate, generating pollutants that affect mankind and the total biosphere in unknown and possibly injurious ways, unpredictable over the long term with today's knowledge; second, the concurrent depletion of our domestically most desirable and easily obtainable fossil fuels. Absolute resources are not today at issue, since for all fuels only a small fraction of the total resources in place have been drawn upon to supply our total energy consumption from antiquity to the present.

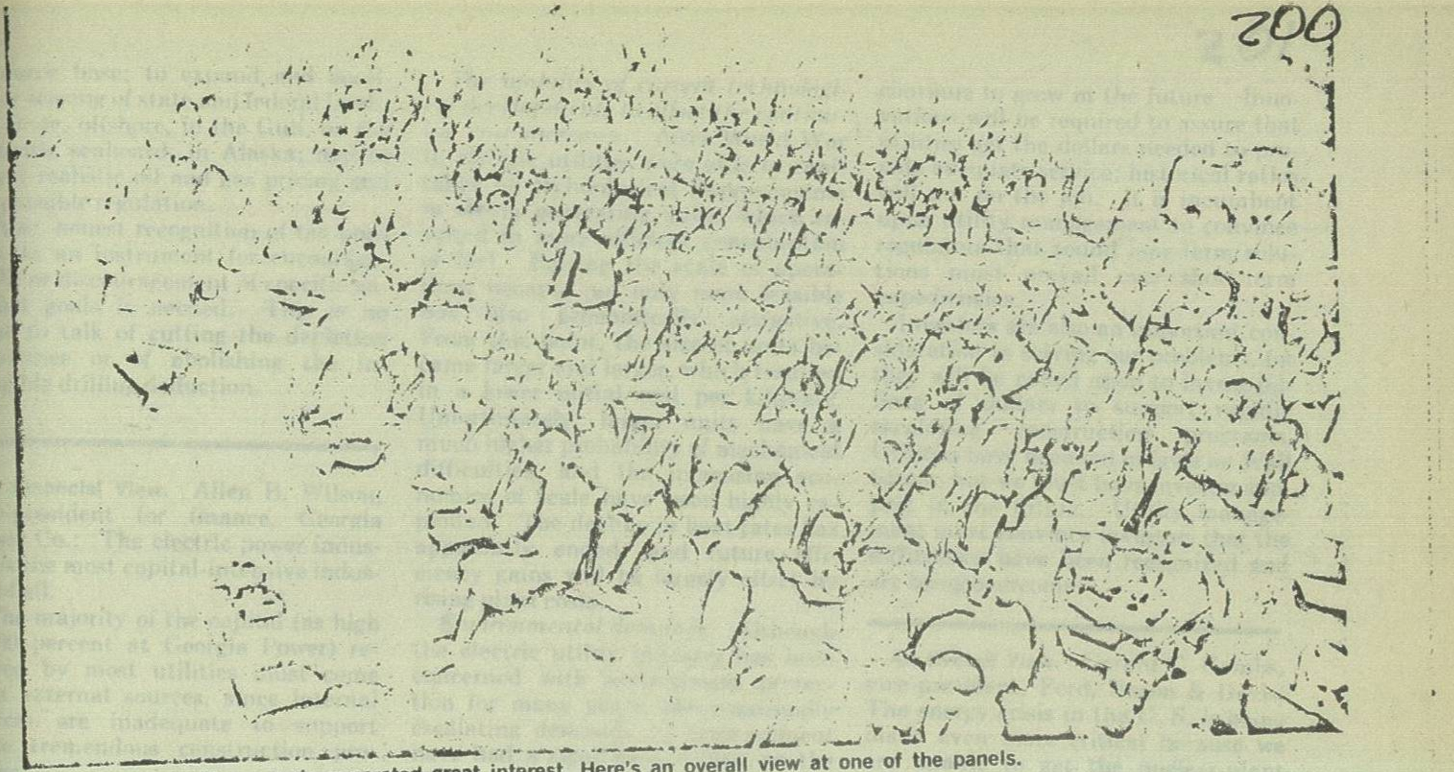
A continuing exponential growth in energy consumption anywhere near the average historic growth rate (approximately a 20-year doubling time) superimposed upon the present magnitude of consumption may run into a domestic-resource limitation of economically obtainable fossil fuels. At today's increasing rate of consumption, another century of low-cost domestic fossil fuels may not exist. Other fuels, particularly nuclear fuels in immense quantities, are domestically available if technology develops fusion or resolves the safety and waste-management problems of fission processes. Depletion of economically producible and environmentally acceptable fossil-fuel resources, increasing daily environmental disturbances, and possible long-term disruption of the total ecosphere are highly probable consequences of our energy-consumption practices.

The above factors, however, are symptoms or effects. To understand why these effects are occurring, we must review the factors influencing energy, environment, and economic interactions. They distill to the following conclusion:

The time response of the marketplace to economic stimulation is much shorter (at least an order of magnitude) than the time response to stimulation of research and development in physical science, technology, biology, or ecology. Decisions based on cost–benefit analysis at current interest rates yield conclusions valid for profit-making industries but not for society. Major revision in institutional factors to allow proper economic interactions between the marketplace and research and development and institutional changes, with their vastly different dynamic-response characteristics, is a first requirement for dealing with the energy crisis. The energy crisis is usually defined in terms of symptoms, not causes. Today's problems are the result of poor foresight and of poor decisions made decades ago. Unless today's approaches can look decades ahead and at the same time deal with today's problems, the energy crisis, no matter how defined, will continue, and its consequences will increase in severity.

A Utility View. W. Donham Crawford, president, Edison Electric Institute: Last year the electric utility industry used slightly more than 328 million tons of coal, 396 million bbl of oil, 3993 trillion cu ft of gas, and 900 tons of uranium. These fuels were used to generate 1532 million megawatt-hours of electricity. During the next two decades, our use of electric energy can be expected to about quadruple, and in the absence of a presently unforeseen technological breakthrough, vastly increased quantities of

Based on The Energy Crisis Forum held concurrently with the ASME Winter Annual Meeting, Nov. 26–30, 1972, New York, N. Y. (A general report of the Winter Annual Meeting can be found in the "ASME News.")



"The Energy Crisis" symposia generated great interest. Here's an overall view at one of the panels.

the basic fuels—particularly coal and uranium—will be required to generate it.

Most energy forecasters agree that by the end of this century about half the energy consumed in this country will be used to generate electricity. To make this possible, the electric utility industry must add substantial amounts of new generating capacity and continue to extend and expand transmission without adversely affecting the reliability of customer service or environmental quality. There have been delays in doing this; the biggest are associated with construction problems.

Intervenors also play a role. The objections we hear most frequently are that electricity contributes to our environmental damage—a position which is generally based on incomplete information and which ignores the contribution electricity makes to cleaning up the environment. We hear that electricity uses too much of our fuel resources—a position that overlooks the fact that where electricity is not used, raw fuels are likely to be consumed directly. We hear that electricity is too cheap—a position with which many utility companies are forced to agree. We hear that the U. S. uses too much electricity, and that consumption should be discouraged by arbitrarily adjusting prices to penalize increased use.

We agree that we must use energy more efficiently. In some cases, achieving the goal of using less total energy will mean the use of more electricity. Substitution of electrified mass transit for automobiles and diesel-powered buses is a good example.

A few guidelines for the future in relation to energy are in order:

We should use energy wisely, not waste it. This means giving greater attention to insulation. It means putting windows back in buildings so that we can ventilate them naturally under some weather conditions. It probably means using smaller cars and more mass transit. Overall, it means looking at each energy use and being conscious of its efficiency and appropriateness.

Research and development efforts should be expanded in order to overcome the technological problems facing the industry and to open up new energy resources. The R&D program should be financed voluntarily and administered by industry, not by government.

Improved regulatory procedures need to be developed. The Atomic Energy Commission, state licensing agencies, and all the other parts of our complex regulatory process need to think about streamlining and, where possible, consolidating their activities.

Probably most urgent, there is a need to establish a national energy council based on the pattern of the National Security Council. A national energy council, composed of the heads of the principal agencies with significant energy responsibilities and reporting directly to the president, could be an effective coordinator of our wide-ranging energy policies.

The Government View. Rush Moody, Jr., commissioner, Federal Power Commission: No one person can state "the government view," for there is no "government view" in the sense of one data base, one delineation of cause and effect, one measurement of probable impact, one program, one agreed-upon set of solutions.

Is the energy crisis real? The answer is yes! How do we know there's a crisis? For four years running we have been consuming gas twice as fast as we are finding new reserves. Where we had a reserve-life index of roughly 20 years in the early 1960s, we were down to 11 years at the end of 1971. Seven interstate pipelines could not deliver the volumes of gas they had contracted to deliver last winter. The shortfall was approximately 500 billion cu ft of gas; this required curtailments which resulted in lower-than-contracted-for deliveries to many customers. Reports filed with us for this winter heating season foretell a doubling in the number of pipelines which have run short—from seven to 15—and a doubling of the shortage—from 500 billion to 1 trillion cu ft of gas.

Where did the crisis come from? In simplest terms, we didn't pay our way as we went. The opportunity cost of natural gas was ignored as the regulatory posture became one based on historic costs. The result was to keep the wellhead price low, but a corollary result was to forfeit replacement of supplies. Markets grew rapidly in response to this illusory "bargain" price of gas, and so, as the result of high demand and low price, we are faced with real concern for the adequacy and reliability of future service, as well as with frustration at higher prices which appear inevitable—for supplements or for underutilized facilities.

What do we do now? We need to insure development of our domestic-resource base; to expand and accelerate leasing of state and federal lands, on shore, offshore, in the Gulf, on the Atlantic seaboard, in Alaska; and to effect realistic oil and gas pricing and responsible regulation.

Also, honest recognition of tax policies as an instrument for encouragement or discouragement of specific national goals is needed. This is no time to talk of cutting the depletion allowance or of abolishing the intangible drilling deduction.

A Financial View. Allen B. Wilson, vice-president for finance, Georgia Power Co.: The electric power industry is the most capital-intensive industry of all.

The majority of the capital (as high as 80 percent at Georgia Power) required by most utilities must come from external sources, since internal sources are inadequate to support these tremendous construction programs.

There are today a number of reasons why financial problems of utilities are particularly acute.

Inflation. In 1968, Georgia Power paid slightly over $7 per ton for coal, whereas the 1972 price is over $10 and is rising. As a general rule, the cost of capital per kilowatt of installed generating capacity has quadrupled in the past 10 years.

The electric industry's heavy reliance on debt financing. From 1960 to 1965, investor-owned electric utilities, on the average, had to finance externally only a little over 43 percent of construction requirements, and debt ratios remained relatively stable at around 52 percent of capitalization. However, construction expenditures skyrocketed during the latter half of the decade, resulting in the industry financing externally more and more in the form of long-term debt.

The inability of current technological developments to offset the continuing cost increases. After World War II, electric utilities were able to capitalize on technological improvements in steam generating units, which resulted in more efficient consumption of fuel. Raising the scale of operations became not only more feasible but also economically attractive. From this point, the size of units became larger and larger, which resulted in a lower initial cost per kilowatt. Unfortunately, larger units have a much higher probability of mechanical difficulties, and the increasing economics of scale have been highly exploited. The decline in heat rates has apparently ended, and future efficiency gains will be largely offset by rising plant costs.

Environmental demands. Although the electric utility industry has been concerned with environment protection for many years, the continually escalating demands for improvement have had a significant impact on the design, on the siting, and, inevitably, on the cost of new facilities. These expenditures are necessary, but they are an additional cost of generation that produce no offsetting revenues, and they thereby reduce the existing economics of operation.

Regulatory lag. This is a major factor. The problem arises with the lag between the time a request, based upon a recent test year, is first presented and the time rates actually go into effect. In some situations, this has taken as much as two years.

The end result of these factors is an unprecedented pressure on corporate liquidity, the company's ability to meet cash needs on time.

Our problems are many, but what about the future? Regulatory commissions are a key element in the resolution of the problems facing the industry. Their responsibilities have been increased tremendously and will continue to grow in the future. Innovations will be required to assure that utilities get the dollars needed to provide adequate service; historical ratios will not do the job. It is incumbent upon utility management to convince regulators that sound long-term solutions must prevail over short-term expediencies.

Investors are also an important consideration in solving our problems, for they will be called upon to invest billions of dollars to support rapidly escalating construction programs. Utilities have been out of favor on Wall Street, but we must have investor support in the future. Utility management must convince investors that the difficulties have been recognized and are being overcome.

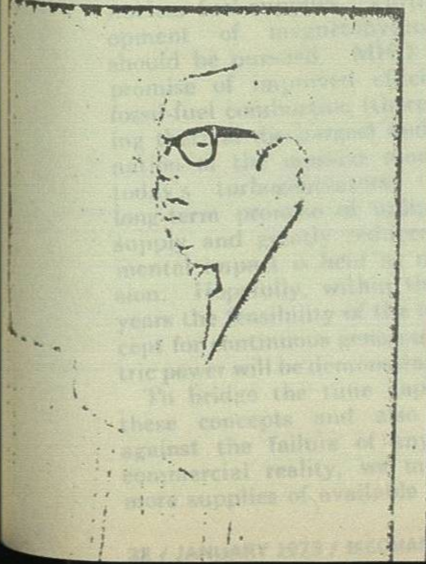
An Overall View. Gerard C. Gambs, vice-president, Ford, Bacon & Davis: The energy crisis in the U. S. is being made even more critical because we are unable to get the nuclear-plant program operating on schedule. We are behind schedule by 15,000 MW as of Jan. 1, 1972, and from all indications will be behind by 30,000 MW by the end of 1972.

The impact on an already stretched fossil-fuel supply is very serious. The effect of a slowdown of each 10,000 MW of nuclear-power-plant capacity is that an additional 100 million bbl of oil per year must be found and burned. Therefore, the current annual shortage is about 300 million bbl, or nearly 1 million bbl per day.

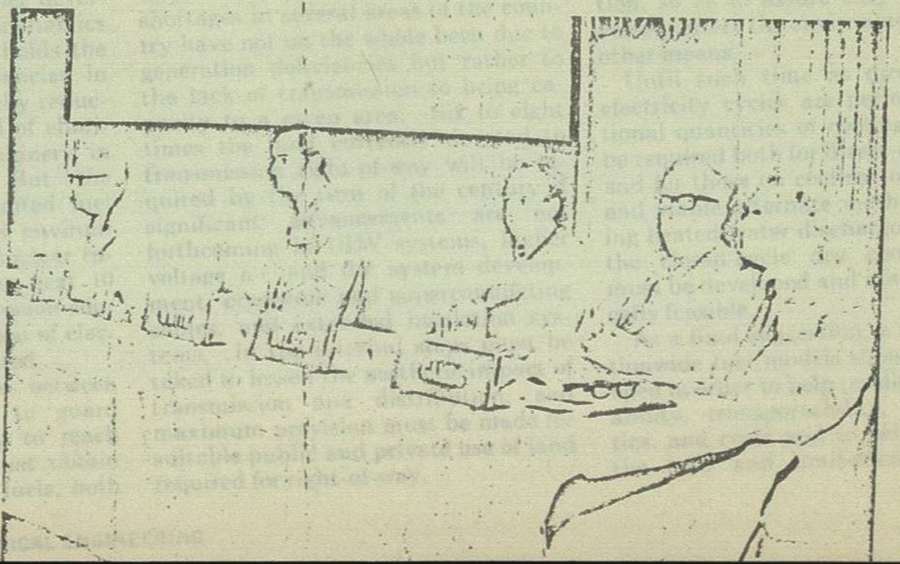
By 1980–1985 we will be able to supply only 55 to 65 percent of our total energy requirements. The balance will have to be obtained through imports, or if we are unable to import this much oil and gas, we will have to do without it.

The agencies that have brought about the present energy crisis in the U. S. are as follows:

Rush Moody, Jr., addresses one of "The Energy Crisis" panels. He presented the government view.



Defining the Crisis. From the left: W. M. Jackson (who acted as moderator), W. D. Crawford, David C. White, Allen B. Wilson, Gerard C. Gambs.



Federal Power Commission. This agency has regulated the ceiling price, at the wellhead, of natural gas for interstate shipments. As a result of keeping the price of natural gas at a fraction of its real worth in the marketplace, the use of gas expanded beyond its normal sphere and displaced other fossil fuels, principally coal. However, the artificially low price set by the FPC was not sufficient to make it economic for more drilling to be done in search of gas. The reserve–production ratio declined steadily during the past two decades, and now the reserves of gas are in peril.

Atomic Energy Commission. The AEC has delayed construction permits for months, and the failure of the AEC and the administration in Washington to move ahead faster with the breeder program can only be described as criminal. The nuclear-power program, without a number of breeder plants by the mid-1980s, will be a failure.

Environmental Protection Agency. The EPA is undoubtedly more to blame for the present energy crisis than any other federal group. The performance standards for air quality that have been put into effect by the EPA have created massive repercussions in fuels supplies and uses. The EPA has caused high-sulfur coal to be unusable in many parts of the country. Is it any wonder that the coal industry is reluctant to invest millions of hard-earned dollars in the development of new coal mines?

Federal Trade Commission. The FTC has been trying for years to make a case for separating coal companies from oil companies and mining companies that had acquired them. The FTC contends such acquisitions have resulted in less competition, since energy companies dealing in oil, gas, coal, and uranium were formed by these acquisitions.

Contrary to the FTC's contentions, the acquisitions of coal companies have strengthened the coal industry by an infusion of vast sums of capital that were spent for developing new mines and new mine capacity. Without these funds, the coal industry would not have survived the past few years.

Simple logic must tell us what is going to happen if the present trends continue:

- A sharp reduction in the availability of oil, gas, and coal, leading to a cessation of all industrial plant expansion unless the company involved has a captive source of energy, preferably within the state that involves the expansion.
- Rationing of all fuels will become the order of the day. Natural gas that is in interstate commerce will be prohibited for industrial and power-plant uses.
- Sulfur restriction on fuels will be eased, but this will happen too late to have any effect on availability of coal, for example. New coal-mine capacity will not appear because of the transient nature of its requirement.
- Unemployment will reach unbearable levels as a result of the slowdown in the economy because of the shortage of energy.
- Blackouts and brownouts will occur because of lack of sufficient generating capacity.

The current problems, mainly environmental, are preventing the licensing of nuclear plants and fossil plants, and this will mean that by the summer of 1973 many parts of the U. S. will be without sufficient reserve generating capacity.

Short-Range Solutions

A Utility View. John Tillinghast, executive vice-president for engineering and construction, American Electric Power Service Corp.: The required near-term developments in electrical-energy field technology lie in four areas: energy conversion, transmission and distribution, environment, and systems.

In the energy-conversion area, expansion of existing fuel supplies, particularly coal, and development of new energy sources are required. The nuclear breeder reactor must demonstrate its viability by the period 1985 to 1990, thereby providing a means for slowing the drain on both fossil and nuclear fuel supplies. Further development of magnetohydrodynamics should be pursued. MHD holds the promise of improved efficiencies in fossil-fuel combustion (thereby reducing thermal discharges) and of elimination of the massive machinery in today's turbogenerators. But the long-term promise of unlimited fuel supply and greatly reduced environmental impact is held by nuclear fusion. Hopefully, within the next 10 years the feasibility of the fusion concept for continuous generation of electric power will be demonstrated.

To bridge the time gaps between these concepts and also to guard against the failure of any to reach commercial reality, we must obtain more supplies of available fuels, both fossil and nuclear. To a large extent this can be encouraged with the development of a rational national energy policy. Technology must also be advanced in the area of combined-cycle generating plants and in coal gasification for conventional and gas-turbine power plants. Progress must also be realized in light-water-reactor technology. Improved licensing techniques must be instituted. Improved efficiencies in fuel processing and fuel transportation are required.

The continued growth in the use of electrical energy will require more and higher capacity transmission and distribution systems. It is exceedingly important to recognize that energy shortages in several areas of the country have not on the whole been due to generation deficiencies but rather to the lack of transmission to bring capacity to a given area. Six to eight times the land currently devoted to transmission right-of-way will be required by the turn of the century if significant advancements are not forthcoming in UHV systems, higher voltage a-c and d-c system development, cryogenic and superconducting cables, and extended insulation systems. In the interim, steps must be taken to lessen the aesthetic impact of transmission and distribution, and maximum provision must be made for suitable public and private use of land required for right-of-way.

We in the U. S. have a great propensity to legislate away problems by making the symptoms illegal, rather than by attacking the basic causes. We have gone far down this road in environmental legislation, without the public understanding the costs and the effects on public demands of such legislation.

In the area of air quality, removal procedures for particulates and sulphur and nitrogen oxides must be determined, and commercially feasible emission-control systems must be developed. Methods must be developed for disposing of these pollutants once they are removed from power-plant stacks or from fuels prior to combustion, so as to assure they do not adversely affect the environment through other means.

Until such time as direct fuel-to-electricity cycles are perfected, additional quantities of cooling water will be required both for direct-cycle plants and for those on cooling towers. New and viable alternate methods of cooling heated-water discharges, including the closed-cycle dry cooling tower, must be developed and made economically feasible.

As a final suggestion, a series of nationwide fuel models should be developed in order to help predict fuel availability, transportability, characteristics, and costs and to help determine the type and limitations of future