Bureau of Reclamation

Judging the energy crisis

Economic problems are critical now, but more basic shortages loom

Only a few years ago energy company officials in the United States were happily envisioning an ever-expanding market for their products. It was axiomatic that the nation's gross national product would grow and grow and that energy, probably the most basic of commodities in an economy devoted to air conditioners, automobiles and powered gimmickry, would pace the growth. This, in fact, had been the experience after World War II. Electric power demand, for example, had doubled about every 10 years.

This dream is by no means dead, and a large segment of the business community—as well as of Middle America in general—still subscribes to a philosophy of the beneficence of endless economic growth. But this year, some cracks have been appearing in the foundation of this edifice. Last spring saw the beginning of an energy crisis (SN: 6/6, p. 550) and the Federal Power Commission last week indicated that the crisis would probably continue into the winter.

The problem has its roots in severe fuel shortages, rather than in shortages of the hardware, such as electric generating plants and transmission lines, needed to turn the fuels into usable forms of energy.

There are indications that these fuel deficits exist primarily because of artificial economic factors rather than any absolute physical limitation on the amounts of fuels available. But pressure on the physical limits is by no means inconceivable in the near future. And today's sufficiency of generating plants could easily become far less than sufficient if demand continues to grow and forces such as environmental concern restrict construction of new plants.

But these are longer term concerns. Although the current energy crisis is at least partly a product of increasingly militant environmentalism, it is still largely an economic phenomenon, one of such immense complexity that the Administration cannot seem to find any commonality of interpretation even within its own ranks.

Chairman Paul W. McCracken of the President's Council of Economic Advisers last week almost directly contradicted FPC's prediction of a continuing crisis when he said a balance between fuel supplies and winter demand had been achieved.

But the FPC based its predictions on detailed reports from utilities all over the nation, and utility engineers generally tend to give FPC more credence than they give McCracken. The three fundamental fuels used in fossil-fueled electric generating plants—coal, residual fuel oil and natural gas—are to some extent interchangeable: Many plants have installed burners that will accept all three with minimal conversion difficulties. All three fuels are in short supply, and the costs of fuel oil and coal have escalated at an alarming rate since last spring. The Nixon Administration's first "inflation alert" this year concerned itself with oil prices rising at an annual rate of 47.6 percent and coal prices at 56 percent. At the same time, natural gas suppliers are pressing the FPC hard for increased rates, claiming they cannot supply the needed gas or pipeline capacity at the current prices. Of the three fuels, only gas is subject to rate regulation.

Nuclear plant component costs have been escalating rapidly for the past few years, and there is a large backlog of orders for the plants. Thus the nuclear alternative to fossil fuel is one that offers only a long-range solution to the energy crisis, if that. The development of commercially feasible fast breeder reactors could, of course, make a major difference someday.

The fuel shortage is a product of many factors. In the case of coal, long-term commitments by coal companies to export their product to Western Europe and Japan have not only limited the amounts of coal available to domestic consumers but also created a shortage of rail hopper cars to carry the coal—the cars are tied up at ports awaiting ships. In addition, new coal mine safety laws and wildcat strikes have increased costs and reduced capacity of coal mines. Strip mine reclamation laws have also boosted costs.

Most residual fuel oil is imported from the Caribbean under a special 1966 provision that exempts this product from oil import quotas. Because the foreign resid has been cheaper than the domestically produced variety, most East Coast refinery capacity is devoted to other petroleum products. But spot tanker rates to carry the oil to the United States have escalated due to a break in a pipeline in the Near East and the need for tankers to sail all the way around Africa from the Persian Gulf. Thus until domestic refinery capacity is increased, high prices for the residual fuel oil will continue.

These are the bare facts of the energy crisis; their interpretation is another matter. Oil companies say that the exemption of resid from import quotas was a mistake and that needed domestic refinery capacity would have been available but for the 1966 exemption. But some economists take almost the opposite view. Paul Fry, staff economist

for the American Public Power Association, says that if there were no import quotas on any petroleum products, oil companies would have to compete with foreign oil across the whole spectrum of petroleum products; thus prices generally would be reduced and the domestic refinery capacity for resid would exist.

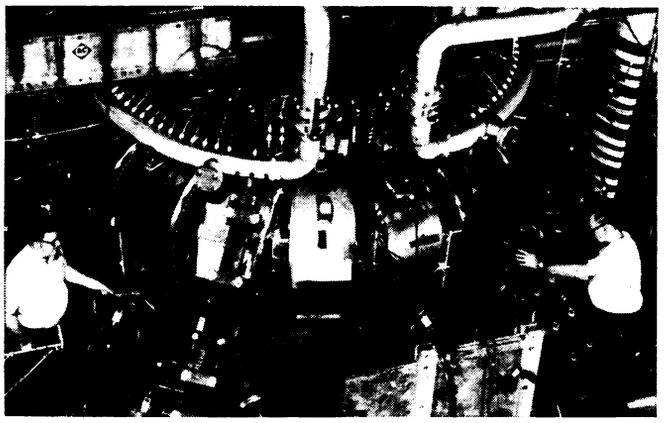
And Dr. Bruce C. Netschert of National Economic Research Associates Inc. says there is little doubt of growing monopoly control by the oil companies of all forms of energy. A succession of mergers during the past few years has given oil companies control of 26 percent of the coal industry, he says. Oil companies have long controlled most natural gas supplies, and oil companies also are rapidly diversifying into uranium production. Fry sees alleged natural gas shortages as a "natural gas strike" by the oil companies for higher rates from the FPC, a strike made possible by the fortuitous shortages of foreign resid and of the coal, whatever their cause.

Industry spokesmen, on the other hand, insist the energy industries are doing their best to provide needed fuels and that shortages are due to escalating costs, environmentalist pressures and inefficient regulation. Willard F. Rockwell, chairman of the board of North American Rockwell, recently suggested, for example, that more liberal antitrust laws governing energy industries—instead of more stringent ones as suggested by Dr. Netschert—are the answer.

The debate will not end soon. And some combatants are arguing that ways be sought to conserve energy resources by minimizing new demand. □

FUSION

Practice leads theory



Princeton Tokamak: As good as the Russian one, maybe a little better.

Princeton Univ.

From the basic principles of the behavior of electrically charged bodies in electric and magnetic fields, a theory can be derived that predicts the behavior of the plasmas of ions and electrons used in experiments aiming at controlled thermonuclear fusion. The only problem is that when experimenters made plasmas and tried to confine them in magnetic fields, this so-called classical plasma theory didn't work—the predicted and observed behaviors were different.

The result was a serious disappointment for theorists and experimenters alike, since the classical theory predicts an easier approach to the conditions of temperature, density and length of confinement necessary for a sustained fusion reaction than the experiments were showing.

From the experimental results theorists began to try to understand the behavior of the actual plasmas and to determine how the classical theory should be modified to make it work. Meanwhile experimenters went on trying to improve their experiments. In the last two or three years experimenters have achieved a number of significant improvements in confinement, but theorists are having as much trouble understanding the successes as they had understanding the earlier failures.

"I used to say," Dr. Harold P. Furth of Princeton University told the meeting of the Plasma Physics Division of the American Physical Society in Washington last week, "that when we understood it, we could make it better. But nature has foxed us and made it better before we understood it."

One of the most celebrated ways that nature has made it better is in a machine called Tokamak that was developed in the Soviet Union (SN: 10/17, p. 321). A Tokamak has a toroidal or doughnut-shaped chamber in which the plasma is held. A large electric coil is built around the toroid in such a way that a current flowing in the coil induces a current in the plasma just as a current in one coil of a transformer induces a current in the other coil. The plasma current both heats the plasma and generates a magnetic field to confine it.

The Tokamak not only held plasma for an unusually long time, but also produced a plasma that was exceptionally stable, lacking many of the disturbances that contribute to loss of plasma in other experiments. The Russian results started the U.S. Atomic Energy Commission on the construction of five Tokamaks. The first of these, at Princeton, has been operating since July.

The Princeton Tokamak is doing about as well as its Russian prototype and maybe a little better, says Dr. Edward Meservey, one of those who has been working with it. When the electric current in the plasma is 40,000 amperes, a plasma of 10^{13} particles per cubic centimeter can be contained for 3 milliseconds at temperatures up to 10 million degrees K. That is what the Russians get with the same current. The Russians claim 7 milliseconds confinement when they use a 100,000-ampere plasma current. So far the Princeton Tokamak is limited to currents under 50,000 amperes; improvements are under way to bring it to 80,000 amperes.

In the absence of a complete theoretical understanding of plasma behavior no particular approach is preferred in principle, and the current successes of the Tokamaks have not made the others roll over and play dead. Heating of plasmas by turbulence, by radial shock (theta pinch), by longitudinal shock (z-pinch) and by laser light are among those under study. Magnetic fields of many different shapes are being used in attempts to confine the plasmas.

Plasmas created and heated by lasers are considered by many a particularly hopeful approach, but says Dr. J. L. Bobin of the Centre d'Etudes de Limeil in France, "Laser-created plasma is about as far from the Lawson criterion (a rule of thumb for self-sustaining fusion) as others."

Says Dr. Lev A. Artsimovich, who led the development of the Tokamak, "Nobody can say right now what kind of closed system is more promising. It may be Tokamaks; it may be Stellarators (a magnetically different kind of toroid). This ingenious idea (the Stellarator), which was created in the United States, should be studied further." □

STRAIGHT WING VS. DELTA

Choosing shuttle options

The National Aeronautics and Space Administration has placed high stakes —its future for the next two decades— on the reusable shuttle (SN: 8/22, p. 178). Its argument is that to maintain