out the independent gas producers in Texas, Louisiana, and Oklahoma who have played an important role in the new discoveries of natural gas. Needless to say, Carter's program singles out the natural-gas based southwestern economy for special attack.

While the long-term impact of such a program would be unmitigated disaster, the short-term impact of the program — even of the announcement of the program — is serious enough. Writing in the *New York Times* on April 21, Leonard Silk simply took for granted that the program would be inflationary and hinted that Federal Reserve Chairman Arthur Burns — an enthusiastic supporter of Carter's "conservation" program — would not respond to the escalating energy prices by reining in the money supply. Back in 1974 in the wake of the 400 percent increase in oil prices, Burns tried to curb inflation, Silk wrote, "and therefore helped bring on the recession of 1974-75." With men like Burns at the helm, it's no wonder that U.S. businessmen are already terrified of renewed inflation and that the interest rate structure will soon rise accordingly.

According to computations of Data Resources in Cambridge, by 1980 the cost of the various fuel taxes — the tax raising domestic crude oil to world prices, the penalty on the industrial use of oil and gas, and the gasoline and "gas-guzzler" taxes — will amount to *$37 billion* a year. Data Resources also predicts that in the first year in which the gasoline and gas-guzzler tax would be in effect, Detroit would sell 200,000 fewer cars. Executives at Ford Motor company are predicting, off the record, that the added $.05 per gallon in year one of the gasoline tax would produce a 4 percent drop in auto sales. It's no wonder then that Detroit is presently haunted by the memories of the production cuts and unemployment lines that followed the 1973 Oil Embargo.

Sensing what the real mood of U.S. industry must be following Carter's energy address, the enterprising Trinidad and Tobago Industrial Development Corporation placed an ad in the U.S. financial press explicitly addressed to energy-intensive U.S. corporations inviting them to come to the islands where natural gas and offshore oil are abundant, and deep water port facilities are newly constructed, and the sentiments are decidedly pro-growth.

Fusion Pioneer Gough:
Utilities See Fusion As 'Next Major Base Load Energy Source'

The following speech was delivered by William C. Gough, Program Manager for Fusion Power, New Energy Resources Department, of the Electric Power Research Institute to the American Power Conference in Chicago on April 18.

During the 1950s and 1960s a modest but determined research effort was underway to assess the possibility of generating power from an unlimited energy source by fusing light elements such as the isotopes of hydrogen. The goal was to harness the same energy source that powers our sun and the stars, and was demonstrated on earth in 1952 by the massive energy release of the hydrogen bomb.

Today, as we draw nearer to this goal, fusion energy deserves careful attention by the utility industry. Progress in the 1970s has been rapid. The federal government's fusion program has expanded by an order of magnitude. The U.S. program is coupled to a closely cooperative and growing worldwide research and development effort currently about $2 billion per year. A combined Electric Power Research Institute-utility effort of about $6 million per year, representing the user input into the fusion program, assures that the industry will be accurately informed of developments in this major energy area.

This paper will examine the prospects for utility application of fusion power. Several points will be emphasized, including progress to date, the critical phase that fusion research and development effort is entering, the urgent need for the utility industry to assure that a useful product will evolve, the multiple uses of this primary energy source, and its role in the energy supply of the future.

Progress Toward Fusion

To generate power from fusion, three factors must be achieved simultaneously. Sufficient fuel must be held at high temperatures long enough to produce net energy, ... the steady and encouraging progression of experimental results that are drawing closer to achieving the "energy breakeven". Fusion experiments at near reactor densities routinely operate up to temperatures of 130,000,000 centigrade. This is about 15 times the temperature of the center of the sun — more than adequate for a fusion reactor. The plasma has been confined in fusion experiments at loss rates quite adequate for fusion power plants, assuming current plasma scaling laws hold. Several devices which will be close to or equal to the goal of "energy breakeven" are under construction or being designed for operation in the early 1980s. These experiments cost up to a quarter of a billion dollars each. Thus, we conclude that fusion is within seven years of a major research goal — the demonstration of a fusion reactor core....

The Critical Phase

Fusion power development is entering its most critical phase. The physics goals of the program are now within reach, the plasma physics community is confident that

the fusion conditions necessary for a power plant can be achieved. There is a good basis for this confidence. In the 1950s the fusion program was three orders of magnitude away from the "Lawson breakeven criterion" of density compounded by time, 10-14 particles per cubic centimeter (a mathematical expression demonstrating the plasma is producing as much fusion as it consumes.) They are now only a factor of five away and the ignition temperatures for fusion plasma have been exceeded in many experiments.

The main thrust of the national and world fusion programs is to proceed rapidly towards plasmas that demonstrate the combined conditions of temperature, density, and confinement time required in a fusion reactor core. The engineering problems that may require solution before fusion power becomes a reality have been evaluated. Although very formidable, they appear amenable to a massive research and development effort of the type mounted in the U.S. to develop technologies of comparable sophistication. The program, therefore, is in a transition phase from research goals to product development. This technical progress has justified the program's recent large funding increases. However, these funding increases have projected the fusion program to the level where it must compete in the political arena on the merits of the product it can deliver. To carry the program to a successful conclusion will require a massive commitment of funds sustained over a long time. As the fusion program rapidly moves toward the demonstration of a fusion reactor core, it is, therefore, equally important that the foundation for a true national commitment to fusion be well established.

This will require the development of a constituency. Such a constituency would include the public who must understand the importance and benefits, the manufacturing industry who must see an opportunity for reasonable profits, and the utilities and other energy-intensive industries who must be convinced that fusion can provide a clear advantage in meeting their critical energy supply problems of the future. No such strong constituency exists today.

There are some who do not view this lack of constituency with the same alarm as I do. They look to the next severe energy crunch to bring in the needed support. I believe this is a *dangerous* assumption. In a crisis we do things we know how to do and which can be done with greatest assurance. New energy sources like fusion even though they offer environmental and other advantages will be sacrificed and their development delayed.

Need To Assure A Useful Product

The key to the successful and timely development of fusion power requires a national commitment to do the job; this commitment in turn requires a strong constituency who believe the job needs to be done expeditiously. This constituency requires the definition of appropriate goals and a working methodology for carrying out an extensive development program to a useful commerical product. (he goes on to say that the utilities must have major input)....

Research and development decisions made during this transition period will have enormous impact upon the utilities. The situation is analagous to that in the 1950s with regard to nuclear fission power. Research and development decisions made then, largely without utility involvement, are the underlying cause of many problems affecting the industry today.

Gough discusses various design modes for utilities, additional application for fusion in power production such as fission hybrids, fusion production of fission fuels and chemical fuels.

What role can fusion power play to solve or ease some of the future energy supply problems of the utility industry? Most utility persons agree that fusion will be the next major base load energy source to supplement fossil fuel and nuclear fission.

Fusion will provide an inexhaustible supply of fuel at insignificant cost....

....A first step in this process might be to provide convincing proof that fusion has passed from a scientific curiosity into a serious product development stage. For example, a possible government-utility cooperative program might be established to construct a fusion reactor core on a present utility system site. Such a reactor core could generate some steam for the existing plant or produce some fission or synthetic fuel and thereby illustrate a useful product output from fusion at an early date. This would represent only the first step towards demonstrating the engineering feasibility of fusion

It must be followed by proof of commercial feasibility, integration into the utility system, and eventual significant use of fusion as a major new energy source.... Just as adequate water is essential to life, so adequate energy is essential to maintain life in our present society by assuring plentifuly food, ease of transportation and communications, hospitals, and free time for education and cultural arts. We would not gamble with an essential for life like water. Nor should we gamble with the essentials for the survival of our society's future.... the utility industry should assure that the national program is targeted to produce a power plant that the industry can use. By assuming this responsibility, the utility industry will provide its unique expertise towards the early achievement of a virtually unlimited energy supply for our children, our country, and our world.