Fusion and the Future

Would not an unlimited energy source be disastrous for mankind?

by Albert A. Bartlett

The process that has been called "cold fusion" was announced to the news media in late March 1989 by Pons and Fleischmann. In mid-April, short statements by two professors of physics at another university came to my attention. These statements dealt with the implications of the possibility that fusion might provide the human race with nearly unlimited energy into the distant future.

Physicist A said, "If fusion becomes self-sustaining, we've got an energy source that is almost unlimited. It would be incredibly beneficial to mankind if it is true." Physicist B said, "If the Pons-Fleischmann breakthrough is for real, then it will be one of the greatest disasters ever to befall mankind."

We can't be surprised that the public is puzzled over scientific issues when experienced university physics professors respond so differently to news of science.

The outcome of the fusion experiments will have a major bearing on the future of industrialized and emerging societies. In any discussion of physics and society, we need to study the implications of finding a source of energy "too cheap to meter."[1]

Western civilization is built on growth. In some circles, continued population growth is regarded as good.[2] Rates of growth of gross national product (GNP) and of the rates of consumption of non-renewable natural resources are an almost universal measure of progress, and some have defined a "recession" as a period in which the annual growth rate of the GNP falls below 2%. The idea of limits to growth was widely rejected by economists and business leaders, some of who felt that the idea of limits was too terrible to contemplate. Others said flatly that there are no limits.[2] Some say that technology will solve all our problems.

If an enormous source of low-cost energy is discovered, it is easy to predict what the immediate consequences would be. Our political and economic leaders would collectively breathe a great sigh of relief and would discard all notions of energy limits. They would rejoice over the advent of a period of uninhibited growth in global rates of energy consumption.

In order to estimate the consequences of likely rates of growth of global energy consumption, we must remember that essentially all of the energy released by human activity winds up ultimately as heat in the environment. First we need some data. The solar power incident on the Earth can be calculated by multiplying the solar constant (1.35×10^3 watts per square meter) by the projected area of the Earth (πR_e^2). This gives 1.7×10^{17} watts, of which 34% is reflected back into space,[3] leaving 1.1×10^{17} watts of solar power entering the earth's atmosphere. Romer[3] shows that the rate of energy use by humans is 8×10^{12} watts. A simple quotient shows that human activities put into the earth's atmosphere about 10^{-4} of the power the sun puts into the earth's atmosphere. The simple arithmetic of growth shows that one would gain a factor of 10^4 in 14 doubling times. At a growth rate of 3% per year, the doubling time is 23 years, and 14 doubling times would take only about 300 years.[4] The arithmetic would suggest that at this modest growth rate, in 300 years human activities would put about as much thermal power into the earth's atmosphere as the sun puts in! The absurdity of this situation is obvious. Independent of the "greenhouse effect," global warming from this direct heating

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would likely render the earth uninhabitable long before the passage of 14 doubling times.

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The signals here are mixed. The good news is that we have seen an international agreement to reduce the use of chlorofluorocarbons, which pose a major threat to the global atmosphere. We see growing concern about the growth of CO_2 and other greenhouse gases, but the bad news is that it is hard to imagine any effective program to reduce the use of fossil fuels, one of the main sources of atmospheric CO_2. Is anyone going to tell the Peoples' Republic of China that it can't construct the large numbers of coal-burning electric generating plants needed to modernize its society? Is anyone going to tell Americans that we can't use our automobiles as much as we want because the CO_2 from the exhaust is harming the global atmosphere?

There is no threshold such that, if pollution exceeds that threshold, people will universally recognize the need for dramatic remedial action. In our cities, people adapt to growing smog and air pollution while political leaders wring their hands and advocate vigorous pursuit of every manner of minor remedial measures while they ignore the fundamental causes. Automobiles are a large source of pollution. The total pollution from autos is proportional to the product of two things: the pollution each car generates each kilometer it is driven, multiplied by the total kilometers driven per unit time by all people in a population. Our political leaders are willing to require that the automakers reduce the pollution per kilometer driven but are unwilling to stop the population growth and the corresponding growth in the number of kilometers driven per unit time. They don't seem to recognize that the benefits of a 5% reduction in the pollution per kilometer of our automobiles are cancelled by a 5% increase in the number of kilometers driven each year.

Many people have modified their attitudes so that they now accept smog. In the same way, some people now seem willing to accept global warming and are now asking how we can adapt to a warming of a few degrees. For example, in a recent conference in Denver, one of the topics was "Will Colorado still be the ski capital of the world if the average temperature of the planet rises 3 – 8 degrees centigrade? How can we prepare for that?" It would be unpleasant to talk about how we might reduce Colorado's contribution to global warming, so, instead, we choose to talk about how we may adapt to the change.

I believe I agree with Professor B in thinking that if an abundant source of low-cost energy is found, it may be the worst thing that has ever happened to the human race.

Whether or not the present efforts in "cold fusion" are successful, we should alert our students to these simple calculations so that they can play a role in the preservation of our global environment. ■

[*I wish to thank Professor George Dulk for calling this conflict of ideas to my attention.*]

REFERENCES AND NOTES

1. This phrase came to be associated in the early 1950s with the glowing predictions for the production of energy by nuclear fission.

2. Julian L. Simon, *The Ultimate Resource*, Princeton University Press, Princeton, NJ, 1981.

3. R.H.Romer, *Energy: Facts and Figures*, Spring Street Press, Amherst, MA, 1984, p. 29.

4. A.A.Bartlett, *American Journal of Physics*, vol. 46, p. 876, 1978.