

More Options Offered for Long-Term Energy Solutions

Before one adopts Albert Bartlett's thesis that population growth must be included in addressing issues of energy shortages and carbon dioxide emissions ("Thoughts on Long-Term Energy Supplies: Scientists and the Silent Lie," *PHYSICS TODAY*, July 2004, page 53), it may be instructive to consider the other side of the energy coin. Perhaps more important than population growth is individual energy consumption. According to Paul Weisz's article in that same issue (page 47), an average American today consumes 10^8 kcal of energy per year, about 10 times more than an individual from a developing nation; the same factor holds for CO_2 emission. It makes one ask, Is our energy consumption in the developed world, and especially in the US, really necessary to maintain our quality of life? Neither Bartlett nor Weisz addresses this question.

If all of Earth's population is to expect the same energy consumption as present-day America, clearly the world is in for real problems. In that case, there will always be wars and suffering as one country increases its population and its energy requirements at the expense of the nonrenewable resources of another nation. The recent war in Iraq is a case in point. Unfortunately, Earth's population is already being controlled by these energy-related forces. For example, Iraq's population is 2.5 million less than it would otherwise have been, largely due to a fivefold increase in child mortality there since the implementation of the United Nations-sponsored embargo.¹

I suggest that it is much more effective, and more just, to ask educated individuals in developed nations to give up their sport utility vehicles and turn off the lights when leaving a room than to ask that illiterate farmers in developing nations

give up their natural desire for children—or even worse, to bomb them.

The solution to the short-term energy supply may not be as problematic as Bartlett implies if one considers improvements in efficiency and conservation. Worldwide, the present population growth rate is 1.2% per year and the rate is decreasing by 3% per year. If this continues, Earth's population will reach a stable maximum of about 8.9×10^9 in about 250 years. If the developed world—say, one-sixth of the world's population—reduces its individual energy consumption by half and the developing world increases its individual consumption to one-fourth that of the US (Japan's individual consumption is presently half that of America's), so that on average each individual in the world consumes 0.225×10^8 kcal/year, then the worldwide energy demand will not grow, and Weisz's graphs for the estimated reserves of oil, natural gas, and coal indicate that we could live happily for at least another 100 years before having to look for alternative energy resources.

Of course, satisfying this stable population in the long term would depend on our ability to eliminate our reliance on nonrenewable resources such as petroleum and uranium by improving our ability to harvest the Sun directly. I believe that physicists should turn their short-term efforts to improving energy efficiency and, like the farmer, their long-term efforts to making better use of solar energy. Let's leave population control to the social workers and politicians, who actually are doing a good job. A physicist who still feels the urge toward social action could preach energy conservation to the developed world.

On a final, perhaps philosophical note, the fundamental purpose of any life on Earth is to dissipate the free energy incident from the Sun. It is a thermodynamic requirement from which we cannot escape. Whether we do our share by increasing our population or by increasing our individual energy consumption is probably thermodynamically irrelevant, since we are still a long way away from dissipating the 10^{22} kcal

per year Earth receives from the Sun. Perhaps the only real silent lie we physicists are perpetuating is to sometimes neglect this thermodynamic imperative. The inescapable good news, however, is that society will continue to invest at ever increasing rates in science and scientists toward the quickest possible dissipation of that free energy.

Reference

1. See, for example, N. A. Nasheit, *J. Matern. Fetal Neonatal Med.* **13**, 64 (2003).

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The debate on energy resources and population clearly includes thoughtful and concerned people on all sides. Responses appear to be based on one of two different models.

In one model, population growth is slowing and will soon stabilize at a level at which both birth rate and death rate are low. Technological innovation and resource substitution will ensure that the Malthusian scenario of food and energy shortages, and their resultant malnutrition, disease, and wars need not occur.

The error in this model is that it only applies to countries where women have access to education and employment and need not depend on childbearing for status and security. But much of the developing world has a rapid population growth rate, due to the application of medical technology that limits infant mortality, without the application of contraceptive technology that limits the birth rate. Rapid population growth limits the use of resources to those needed for survival, with little left for education and job training, especially for women. They have no alternative to childbearing as a way of ensuring for themselves a respectable place in society.

In the other model, a high level of education and participation of women in the work force has stabilized the population in the developed countries. They have a low birth rate that balances a low death rate. But that is not happening in underdevel-

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