Energy

The article "Where is Energy Going?" (February 2000, p. 16) projects hydrogen as the next-generation fuel after methane. Unfortunately, hydrogen is as hard to store as electricity. It requires cryogenic temperatures or extremely high pressure. The author also dismisses solar and wind power in favor of nuclear power stations on a quantity basis. I would point out that the yearly energy from the sunlight falling on the earth is more than 1,000 times the total lifetime energy output of all the world's nuclear power stations. In fact, the 2-GW average sunlight falling on a typical 2,000-acre nuclear power station is more than the power produced by the reactor. What the author certainly did get right is that storage is the problem.

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[*Author replies:* Hydrogen is stored successfully today, and more successfully each year. By 2050, when our graph predicts that hydrogen will begin to gain the leading role in the energy system, we are confident that industrial physicists will have achieved many good solutions for hydrogen storage. Solar exploitation requires large and complex machinery. To produce, with solar cells, the amount of energy generated in 1 L of the core of a nuclear reactor requires about 1 ha (10,000 m^2) of solar cells. To compete at making the thousands of gigawatts needed for the heart of the energy market, the cost and complexity of solar collectors still need to shrink by orders of magnitude and efficiency must soar. Extrapolating the progress (or lack thereof) in recent decades does not carry the solar system to market victory. Electrical batteries,which are crucial to many applications, weigh almost zero in the global energy market. Similarly, solar energy may attain marvelous niches, but it seems to be an ill-suited way of providing the base power for 10 billion people later this century.

Jesse Ausubel]

Since you conclude that hydrogen will be our fuel in the future, with nuclear fission as the primary energy source for "producing" most of the hydrogen—-from the electrolysis of water, I assume—-the next question is: How much fission fuel is there? I've long had the impression that total fissionable resources are fairly modest, so that even if the waste problems are solved, fission can't really be a long-term source of primary energy. I know that breeder reactors give a substantial multiplying factor, but I thought the total resources were modest, even with that boost. Am I wrong?

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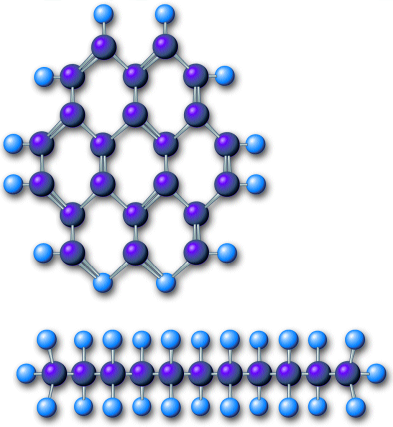

[*Author replies:* The sea contains 5 billion tons of dissolved uranium, and th amount of uraniur contained in the cooling water of reactors cooled with seawater car 10 times that fissic uranium, assuming ocean recirculation of 1,000–2,000 years, could take care of energy for the next 10,000 years. The Japanese continue to work a lot on extracting uranium from the sea, and they are making excellent progress. Fusion is fine, too, of course. By 2100, it may be commercially important.

Jesse Ausubel]

I read your article on the future of energy (*The Industrial Physicist*, February 2000, pp. 16–19) with great interest. I am a plasma physicist at the Naval Research Laboratory, and for a while I was involved in magnetic fusion—the largest application of plasma physics. As you probably know, magnetic fusion has fallen on rather hard times. For at least a decade, I have thought that fission fusion is the best approach for the fusion project to take. This would allow the project to couple to a revived nuclear power scenario, and ultimately, if fusion can make it on its own, would allow fusion to be used for either electrical or hydrogen production.

About two years ago, I had an opportunity to study this issue in some detail (for about three months), and I documented my conclusions in "Back to the Future: the Historical, Scientific, Naval, and Environmental Case for Fission Fusion" [*Fusion Technology*, 1999, *36* (1)]. If you are interested, I would be happy to send you a copy of the article. I think fission fusion may be a way in which magnetic fusion could fit into the sort of schemes you propose.

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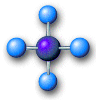
Teaching



I have grown tired of the politics and low pay that I have found in academia. I have resurrected my consulting business, and I am finding clients. I am writing to find out whether other physicists who subscribe to *The Industrial Physicist* are doing consulting work. In addition, I would like to request a section in the magazine devoted to consulting (i.e., making proposals and contracts, dealing with clients, finding prospects, understanding the Small Business Innovation Research program, etc.).

I have just returned from California, where I worked on a consulting contract. The difference in the rate of compensation compared with that of a faculty position is astronomical. I will make the leap to full-time consulting in the summer. I cannot believe that after a physicist spends 12 years in school to obtain a Ph.D., most universities want to pay at lower rates than those that other B.S. students get when they graduate and go into industry. I am a very good physics teacher with a passion for teaching. It is too bad that I can't afford to teach.

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I am the physics instructor at Gulliver Preparatory High School, where I teach juniors and seniors who are ready and motivated to select what to do with their lives. It has become increasingly difficult to show them how a physics graduate can use his or her knowledge and skills. Another difficult task is to show them how physics applies to industry and technology, so I was lucky last week to receive, from a friend, an issue of your magazine (December 1999). It had some excellent articles, such as "Physicists Graduate from Wall Street" [p. 9] and "Putting Nanotubes to Work" [p. 22]. Guess what? Magic happened. We spent one complete period just talking about these articles and some other possibilities for physicists. I think that your magazine is the perfect tool to establish a link between high school classrooms and the real-life applications of physics.

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Superconducting motor

I would like to clarify some points made in a letter to the editor (*The Industrial Physicist*, December 1999, p. 4) regarding superconducting motor development at Reliance Electric/Rockwell Automation. While it is true that the 200-hp high-temperature superconducting (HTS) motor was cooled by gaseous helium, this motor was demonstrated (at four times the rating originally proposed) with superconducting coils operating at 27 K and not 16 K as stated. The superconducting rotor for the 1,000-hp HTS motor—which was designed,built,and to date thermally tested by Reliance Electric under the U.S. Department of Energy's Superconductivity Partnership Initiative—is expected to have an operational temperature of 30 to 33 K during motor tests. Further, while it is also true that the HTS materials do not yet have adequate performance in the field at 77 K for the motor application, steady progress in the in-field performance of HTS wire is being achieved. As performance improves, motor demonstrations at higher operating temperatures will be pursued. There may be design advantages for operating at these lower temperatures, however.

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