ISSUES IN SCIENCE AND TECHNOLOGY online
Summer 2004

Book Review

Energy futures

Energy at the Crossroads: Global Perspectives and Uncertainties, *by Vaclav Smil. Cambridge, Mass.: MIT Press, 2003, 448 pp.*

James J. MacKenzie

Vaclav Smil has done it again. He has written yet another important book on energy and has managed to make it interesting, readable, and rich with data and references.

He begins by examining the historical evolution of today's energy system--the major trends; the energy transitions; the growth in the energy factors affecting global warming; the roots and impacts of wars on energy; and the social, technological, and economic forces that have affected energy production and use. He also explores the connections among the economics of energy use, the trends and interpretations of various energy indicators, environmental impacts, and externalities. And he reviews what is known about the more common air pollutants and summarizes their legal status; describes the growing role of carbon dioxide as a greenhouse gas; and, in recognition of current events and the terrorist attacks of September 11, 2001, discusses the revolutionary impacts of energy forms on modern warfare and terrorism.

In one cautionary note, Smil says the nation should not rely heavily on long-term energy forecasting when it comes to setting energy policies. Such forecasting, he says, has always been a failure--a conclusion that is difficult to disagree with. Reaching conclusions through the use of computers cloaks the results with an air of reliability that really is not warranted. He cites, for example, predictions about the emergence of specific technologies that turned out to be completely wrong. One need only think of the federal push for the adoption of liquid metal fast-breeder reactors to see how far wrong

officialdom can be.

"We should abandon all detailed quantitative point forecasts," he says, by which he means such things as total energy demand 20 years from now. In his mind, there are only two ways of looking ahead that are of value. One is to look at contingency scenarios for the results of a worldwide depression or a conflagration in the Middle East, and the second involves examining "no-regrets" scenarios that can guide reconciliation with the biosphere.

As to the future of fossil fuels, Smil examines the issue by asking, is the decline of global crude oil production imminent? This is, to put it mildly, an issue of some importance both nationally and worldwide. Indeed, one can argue that the United States is in a state of war in Iraq in large measure to ensure access to the vast petroleum reserves in the Middle East. The present dispute over global oil production began in 1956 when the Shell geophysicist M. King Hubbert predicted that in the United States, crude oil production in the lower 48 states would peak in the late 1960s and then start to decline. At that time, U.S. cumulative production had reached 50 billion barrels, and experts generally agreed that the total U.S. crude oil resource base was between 150 billion and 200 billion barrels. As it turned out, crude production peaked in 1970 and has been declining since, and current estimates point to a total quantity of crude oil equal to 200 billion barrels.

I have carried out a similar analysis for global conventional crude oil production, and the results suggest that the amount of ultimately recoverable global crude oil is at least 1,600 billion barrels, but could be as much as 2,600 or even 2,800 billion barrels. If these limits are true, then production is likely to peak between 2010 and 2020, not very far into the future.

What would be the implications of such global peaking? As oil economists point out, this would not signal the end of burning fossil fuels. There are huge deposits of solid carbon fuels waiting to be converted into liquids; Canada, for example, has huge deposits of oil sands, rivaling Saudi Arabia in sheer resources. There would be, however, a high price to be paid to pursue the synfuels path. Crude oils made from solids would have even higher carbon dioxide emissions than conventional crudes. Moreover, producing nonconventional oil could be an environmental mess, with extraction operations resembling surface mining for coal. Clearly, for reasons of global warming and environmental disturbances, large-scale oil production from oil sands would not be a sustainable element in a long-term energy strategy.

So how to replace fossil fuels? Smil describes a number of nonfossil options, including such renewables as flowing water, solar, wind, waves, and biomass. The technologies to harness these energy forms are described individually, along with their estimated benefits and costs. Smil is particularly fond of wind power and photovoltaics. But though he sees rapid growth in installations and major contributions of these technologies to world electrical supply, he offers no estimates of their potential contributions in the coming

decades.

Looking at some numbers may suggest the possibilities. Consider wind power. In 1985, the peak wind capacity in California was just over 1 gigawatt (GW). Capacity had grown to 2.6 GW by the end of 2000, with a doubling in capacity planned during 2001. Wind was growing even faster in Europe, where it accounted for 13 percent of total generation by the end of 2000 and is expected to total 100 GW by 2030. Some plans forecast that by 2020 wind will account for 10 percent of the world's electrical capacity. At these rates, wind can make sizable contributions to slowing the atmospheric buildup of greenhouse gases. But by how much? Smil's book leaves that as a problem for the reader to determine.

Photovoltaics also have been growing rapidly. By 2000, cumulative installed capacity had reached 500 megawatts in the United States and almost 1 GW worldwide. According to the National Center for Photovoltaics, 3.2 GW of capacity will be installed in the United States by 2020. Ultimately, total installed capacity will reach 15 GW in the United States and 70 GW worldwide.

Not only are they renewable, wind and photovoltaics produce electricity without air pollution or greenhouse gas emissions. Unfortunately, they both pose major problems of intermittence and portability (for transportation). To overcome their intermittence, some form of backup or energy storage is needed. Advanced batteries would be one way to store excess power, but hydrogen combined with fuel cells may be even more promising. Hydrogen would be produced by electrolysis when demand from the grid exceeds the supply of renewable electricity. Hydrogen also could serve as a portable form of power, particularly for use in automobiles, trucks, and perhaps airplanes.

Smil discusses the technological status, cost, and performance of hydrogen technology in some detail. Two serious problems, he says, remain to be resolved. One problem is developing storage that is cheap and large enough in volume to power a vehicle for several hundred miles. The other is safety, though some observers argue that this problem can be dealt with through suitable safety regulations and appropriate technological fixes.

The book also considers the option that everyone concerned with energy faces at one time or another: nuclear power. On the future of this technology, Smil is not an optimist. He cites Alvin Weinberg's Faustian bargain, whereby the benefits of clean nuclear power were given at a price of eternal vigilance and care that seems never to have been realized. The tradeoffs for building nuclear plants include, in the worst of circumstances, environmental (accidents) or military (proliferation) catastrophes. Smil also decries the government's failure to store radioactive wastes, and he points out that the costs of building new nuclear plants and their levels of performance are highly uncertain.

Smil ends with a discussion of possible energy futures. Given his skepticism

about forecasting, it should come as no surprise that he offers no modeling results with numerical estimates of future energy supply and demand. Rather, he offers what amounts to an essay on long-term energy trends and the factors affecting them. He also describes a collection of energy sources and technologies that he favors (renewables, hydrogen, hydro dams, and improved efficiency) and those he does not care for (fossil fuels, geoengineering, and nuclear power). He calls for subsidies to support the sources that are environmentally preferable: wind and photovoltaics.

Even in citing a role for improving energy efficiency, Smil is pessimistic that this approach will do much to control national energy demand. Efficiency improvements, he says, will not curb energy growth as much as expected, because of the rebound effect. That is, initial efforts to reduce energy consumption will lead to economic savings that consumers will spend, in the process creating more demand for energy.

One of his principal concerns is about future energy use and its impacts on global warming. He has little use for the Kyoto Protocol, declaring that "even a fully implemented Kyoto Protocol would have done little to prevent further substantial increases of [greenhouse gas] emissions," and labeling the agreement merely "a timid start in the right direction."

In one minor quibble with the book, I would have liked Smil to have done more in identifying and discussing the historical people who have been instrumental in the evolution of today's modern energy system. But this gap can be easily overlooked given that the general topic--the strategic energy decisions we will have to make in the near future--is so vital. Smil covers well most of the important topics from a variety of perspectives, including environmental, economic, and technical performance. On these issues, his book serves as a good introduction. It should prove especially useful for academics who teach courses on contemporary energy issues, and may well help point the way to a more secure energy future.

James J. MacKenzie (jim@wri.org) is a senior associate at the World Resources Institute in Washington, D.C.