BOOK REVIEWS

Energy in Nature and Society: General Energetics of Complex Systems

Vaclav Smil
MIT Press; 2008; xi + 480 pp.; ISBN 978-0-262-19565-2; $75.

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The topic of energy is in the news a lot these days. Not only are we concerned about having enough energy for today's civilization and tomorrow's needs, but also energy is at the core of our understanding of the inner workings of the Sun, Earth, and life itself. Indeed, energy may well be the most common currency in all of natural science, helping us to appreciate where we came from and guiding us toward a sustainable society in the future.

Energy plays a vital role in the origin and evolution of all complex systems in the universe, including galaxies, stars, planets, and life forms. Treating each of these systems as open thermodynamic structures that acquire, store, and express energy, it can be shown that over billions of years since the Big Bang, the energy rate densities (watts per kilogram) of these systems have risen with the cosmic march of time. General, coherent worldviews, based largely on the concept of energy, are now being developed by many researchers around the world. I certainly share many of my colleagues' enthusiasm for the fundamental function of energy in our world and for the need to study it more.

During the past 20 years, Vaclav Smil, a geographer at the University of Manitoba, has written more than a dozen books on energy and its derivatives. In each book, he has demonstrated an encyclopedic knowledge of the subject; a welcome empirical basis for his arguments; a keen insight into energy's many interrelated processes among Earth, life, and civilization; and a knack for clear, perceptive illustrations.

Energy in Nature and Society is largely a consolidation of several of Smil's earlier works. It surveys energy broadly—its flows, uses, and consequences—in Earth's biosphere and civilization. Environmentalists, policy makers, and just about anyone interested in today's vexing energy issues will find Smil's treatment of energetics both thorough and quantitative, yet topical. His ongoing discussion of trends and patterns that led to our socioeconomic love affair with energy today is especially absorbing. About one third of the book is devoted to biological subjects, including plant photosynthesis and animal metabolism; nearly as much addresses the evolution of humans' early control of energy, including food production, growing industrialization, and societal infrastructure; and much of the rest of the book concerns modern society, including fossil fuels, machine operation, economic balance, and the prospects for humanity's future on Earth. None of the book is a quick read, as this large volume often seems as complex as life itself.

This is a fine book, yet densely written and at times overly detailed, with a wealth of topical information in text and numerous numerical values in tables and graphs. To many of my colleagues, Smil's books resemble technical handbooks, albeit written with literary flair, to dip in and out of while searching for energy-related quantities and their trends in space and time. However, *Energy in Nature and Society* is not a textbook; there is little pedagogy that would be useful in the classroom. Nor are there any color illustrations, despite the book's steep price, though there are extensive references and a useful index.

The book's biggest weakness is a lack of coherence; despite its subtitle, the book is hardly a general exposition on energy. As Smil moves from Earth to life to society, he tends to use a wide spectrum of energy terms and disparate units for which he presents no underlying unity; he expresses planetary energy flows in watts per square meter yet expresses life's bioenergetics in watts per gram and the powering of industry in joules per kilogram, the last of these variously called in this book energy density, energy content, energy intensity, energy cost, specific energy, and heating value. Throughout, some values of quantities are given in physicists' preferred centimeter-gram-second (cgs) units while others are given according to the International System of Units (SI), and some even have hybrid units that mix different measurement systems, among a whole host of energy-related, but often dissimilar, terms and units that will keep even energy experts off balance. If this were a true study of general energetics, Smil would have more uniformly and consistently treated each of the many complex systems encountered in the natural world. Furthermore, his description of nature is largely limited to Earth and its living systems; the author does not cover complex systems beyond Earth, save for a few error-prone pages early on.

Another drawback of this book is that it looks, reads, and actually is similar to Smil's many previous "bestsellers" (his term) on energy. MIT Press has published several books on the same topic by the same author, and although new content doubtless laces the present volume, much of the book is mined from his earlier works. Many of the figures, which are a pleasant hallmark of Smil's books, are identical to those published earlier. Thus, readers unfamiliar with Smil's extensive writings on the subject will gain much from this book, but those who have read one or another of his prior works are unlikely to find many new insights, factoids, or generalizations regarding the role of energy in nature and society.

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