

who were pioneers in recognizing the cyclical nature of industrial stocks and its interplay with human societies. Throughout the book, the editors do well to highlight technology more directly than in past discussions of industrial ecology by recognizing the role of technology legacies from the past or options for the future in strongly influencing the range of possible environmental outcomes.

After finishing both volumes, the reader may well ask, "Where is the nature analogy that is said to reside at the heart of industrial ecology?" Indeed, early in the first volume, the chapter by Isenmann and colleagues, "Beyond a Sack of Resources: Nature as a Model—the Core Feature of Industrial Ecology," offers a useful taxonomy of approaches to environmental modeling vis-à-vis nature. The chapter concludes that the "industry as ecosystem" model constitutes what is, in fact, the unique and defining feature of industrial ecology. The following contributions, however, never really revisit this initial conclusion. Instead, we find an implicit understanding that one must take a systems perspective to understand complex social systems as they affect environmental performance. Other than a general reliance on the 19th-century notion of "society as organism" and the pursuit of a sufficiently nuanced social model, no indication is given that nature should be used as the inspiration for the model. Although nature may provide a fine example of a complex model that involves many subsystems, the complex systems perspective does not equate with the use of nature itself as the model. For example, others have noted that although natural systems may be resilient, they are not typically optimized for efficiency; such consideration would find no place in these volumes, where any discussion of the actual character of natural ecosystems remains unaddressed. Are industrial ecosystems simply a generic example of complex systems? Should industrial ecology be viewed simply as a combination of operations research and organizational studies?

After reading this collection of well-written essays, one is faced with the question of whether industrial ecology seeks to characterize systems faithfully or whether it aims to allow for the prediction of behavior of those systems. Although exploratory studies and modeling ex-

ercises represent necessary steps for advancing research on characterization, for prediction to be possible, their goal must be to refine the state of knowledge, sometimes by revealing approaches to be inadequate. The distilling of knowledge in this way will allow for its use to benefit the conditions of human societies in the future.

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Energy in Nature and Society: General Energetics of Complex Systems by Vaclav Smil. Cambridge, MA: MIT Press, 2008, 512 pp., ISBN 9780262693561 2008, \$34.00 (paper).

This book now appears 17 years after Smil's first groundbreaking effort at reestablishing the subject of general energetics across natural and human systems, across earth and human history, and across scientific fields. Anybody who had discovered his earlier book as a treasure trove will be fascinated and delighted by this new volume: It maintains the freshness and lucidity of the previous version but integrates—without losing the link to the longer scientific history of each issue—a vast amount of literature that has appeared in the meantime. Even in the age of Google and Wikipedia, such a comprehensive book is indispensable. The reader will be impressed by and grateful for the almost incredible self-discipline of a writer who focuses on the very essential. The book includes not one footnote; every two to three pages, there is a very well-chosen diagram or a picture (often of special historical meaning and aesthetic quality); each two-column page contains about 50 numbers (a rough estimate). The whole 500-page compendium is an organized assembly of dozens of well-selected state-of-the-art reports, carefully done and trustworthy. In several fields of my own research interest, I would have been well advised to consult Smil first—it would have saved me a large amount of effort. And the book is so well indexed that one finds anything one is looking for.

The volume is structured in 13 chapters, starting off with a chapter on the intellectual history of energetics, followed by a chapter on planetary energetics (the sun; earth's radiation fluxes; thermal, mass, and kinetic fluxes; and geoenergetics). Chapter 3, on photosynthesis, the "Bioenergetics of Primary Production," demonstrates Smil's lack of technological bias in dealing with the subject of energy; it is followed by a chapter on heterotrophic conversions. (What I liked in this chapter in particular, and that existed in the previous editions in rudimentary form only, is an excellent review of the literature on allometry and scaling laws, one of the "grand" generalizations in biology that is, however, still in flux).

Chapter 5 deals with human energetics (as does the remaining two thirds of the book), starting off with the intricacies of nutrition and locomotion and ending with a discussion of the diverse findings on human hunters and gatherers. Chapter 6 is devoted to humans as "solar farmers" and traditional food production. In this chapter and also in the next, on "preindustrial complexification," the author's solid knowledge not just of European but also of Chinese agrarian history becomes apparent (he also published a book on China's environmental crisis) and adds flavor and generality to his discussion. In Chapter 8, the turn is made to fossil-fuel-based energy regimes—first on heat, light, and prime movers and then, in the following chapter, on the patterns and trends of fossil-fuelled civilization. These patterns and trends are not as regular as once expected: Transitions between energy sources do not follow projections (in particular, because nuclear energy did not take off and coal remains a major source on the global level); demand for electricity is rocketing, and supply is even more unevenly distributed than for other forms of energy. Can energy savings and efficiency gains lead to lasting reductions? For this very typically "industrial ecology" question, Smil has a fairly clear answer: Although he is convinced that the highly developed countries could do with 50% less total primary energy supply (TPES) without a reduction in comfort, he is sceptical that efficiency gains and savings will translate into long-lasting reductions (p. 271), particularly because of rebound effects.

Chapter 10 discusses energy costs for producing energy and energy costs of some key ma-

terials, such as cement, steel, aluminium, and ammonia. For the energy cost of materials, Smil displays time series that demonstrate the substantial efficiency increases since the industrial revolution, shows that some improvements approach their theoretical limits, and presents an interesting discussion on the energy return of agriculture, questioning too strong a focus on energy (and not on other factors, e.g., working time or quality). In the next chapter, on environmental consequences, one finds surprising calculations on power densities—watts per square meter (W/m^2), one of Smil's favorite indicators—in relation to population densities and energy supply facilities, and on heat rejection rates. These, in the end, produce much less of a challenge than the human interference in the grand biospheric cycles, most of which is related to the combustion of fossil fuels (p. 333).

Chapter 12, titled "Energetic Correlates: Complexities of High-Energy Civilization," starts off from long-term decreases of the energy intensity of economies (megajoules per dollar) and then joins the debate on using energy (resp. some derivatives, e.g., exergy or emergy) as a "true" measure of value (Odum 1971) or key driver of economic growth (Ayres and Warr 2009). As usual, Smil plays the sceptic: "We should definitely pay attention to embodied and net energy, but we must also realize that even such a fundamental entity as energy... cannot be an adequate surrogate for valuing space, time, qualitative attributes of materials, biodiversity, mental labor, ideas, social order, cultural riches, and morality" (345f). Chapter 13, then, fortunately (given its number) does not show a grand or gruesome outlook into the future but deals concisely with the "grand patterns." So Smil is certainly not a guru of "energy is all that matters," and he is both assertive and humble enough not to make a guru of himself—but he deserves people's trust more than if he were.

When I had finished reading the book (and this took me a full rainy weekend—a most rewarding way of spending it), I remembered a classification by the cultural theorist Thomas Macho published in the German weekly *Die Zeit* (1993). According to Macho, there are hunters and gatherers also in science, interdependent but a little sceptical of one another. Hunters are the ones

who grab for the big theories (and often keep their people hungry); gatherers are the ones who sort out and collect all the evidence that reliably provides the daily food. Smil falls rather on the gatherers' side. But this is exactly why this book deserves its place not only in libraries serving students of society-nature interaction but also in private bookshelves, so it can be consulted liberally for any of the broad variety of subjects with which it deals. The short and smart quantitative appendix and the 60 pages of references alone are well worth the book's price.

(Vaclav Smil left Czechoslovakia after 1968 as a dissident and now is a distinguished professor at the University of Manitoba, Canada.)

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References

- Ayres, R. U. and B. Warr. 2009. *The economic growth engine: How energy and work drive material prosperity*. Cheltenham: Edward Elgar.
- Macho, T. 1993. Jaeger und Sammler in der Wissenschaft [Hunter and gatherer in science]. In: *Freitag: Die Ost-West-Wochenzeitung* nr. 32 (Aug. 6), p. 11.
- Odum, H. T. 1971. *Environment, power, and society*. New York: Wiley.



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Urbanization Challenges in China: Critical Issues in an Era of Rapid Growth edited by Yan Song and Chengri Ding. Cambridge, MA, USA: Lincoln Institute of Land Policy, 2009, 320 pp., ISBN 9781558441750, \$30.00.

Smart Urban Growth for China edited by Yan Song and Chengri Ding. Cambridge, MA, USA: Lincoln Institute of Land Policy, 2009, 287 pp., ISBN 9781558441835, \$30.00.

Urbanization in China is a hot topic. It is intriguing and fascinating to realize that, each year,

18 million people move into cities and that by 2050, there will be an additional 400 million new urban dwellers in China, which could in itself form the world's third largest country. A transformation of such scale would naturally bring along a huge set of issues. How to plan, finance, and manage such urban growth is an urgent challenge facing the country, which, in turn, has a profound impact on resource demand and environmental impacts of cities. This megatrend in human settlements and their impacts—both in China and in other parts of the world—is a key driver for the growing interest in the industrial ecology community in studying urban systems that use concepts such as urban metabolism.

The two edited volumes by Yan Song and Chengri Ding, titled *Urbanization Challenges in China: Critical Issues in an Era of Rapid Growth* and *Smart Urban Growth for China*, with contributions by Chinese as well as overseas scholars, provide some good insights into this topic, in particular around land use and planning issues.

The first volume aims at taking stock of China's urban expansion, highlighting various challenges as well as accomplishments associated with rapid urban growth, those connected to land in particular. The volume consists of 13 chapters, organized in four broad categories: urban planning in the face of urbanization, land use policy, rural-to-urban migration and its implications, and financing China's urbanization.

Reading the book, one realizes that many of the issue it highlights are quite common to rapidly urbanizing developing regions in the world—for example, how to provide housing, education, and basic services to rapidly growing cities. The book suggests the importance and potential of learning from international experiences.

Some issues discussed are unique to Chinese urbanization. These include the coexistence of strong central policy and the much stronger spending power of local government compared to other countries, the unpredictability of local income sources, the lack of transparency in the municipal finance system, and the legacy of the planned economy with respect to the issue of nonperforming loans.

The similarities can be more surprising than the differences. For example, China has generally been regarded as having no slum areas in