

Energy in nature and society: general energetics of complex systems

Vaclav Smil, 2008, MIT Press, Cambridge

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Reviewing a book on energy by Vaclav Smil is like reviewing a drama on kings by Shakespeare. This book now appears 17 years after his first groundbreaking effort at re-establishing the subject of general energetics across natural and human systems, across earth and human history, and across scientific fields ranging from atmospheric chemistry to plant physiology, from zoology to human nutrition, and from cultural anthropology to economics (to name just a few).

Anybody who had discovered his earlier book as a treasure trove will be fascinated and delighted by this relaunch that maintains the freshness and lucidity of the older version, but has integrated—without losing the link to the longer scientific history of each issue—a vast amount of literature that appeared in the meantime. Those who are not yet familiar with Smil's work, will also, in the age of Google and Wikipedias, be impressed by the almost incredible self-discipline of a writer who focuses his reader's attention on the very essential—and be grateful for this. There is not one footnote; every two to three pages, there is a schematic 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 organised assembly of dozens of well-selected state-of-the-art reports following a lucid conceptual structure, 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 preserved me from clumsy efforts at re-inventing the wheel. But, I admit, one needs to overcome a spontaneous

shyness vis-à-vis such an intimidating accumulation of wisdom.

The book is structured in 13 chapters, starting with a chapter on the intellectual history of energetics, followed by a chapter on planetary energetics (sun, earth's radiation fluxes, thermal, mass and kinetic fluxes and geoenenergetics). Chapter 3 is on photosynthesis, the "Bioenergetics of Primary Production", demonstrating Smil's lack of technological bias in dealing with the subject of energy, 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, however, still in flux). Chapter 4 deals with human energetics (as do the remaining two-thirds of the book), starting 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 China's agrarian history becomes apparent (he also published a book on China's Environmental Crisis) and adds flavour 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, to the patterns and trends of fossil-fuelled civilisation (Smil is too accurate of a scientist to term it a fossil civilization, as he might). 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 even more unevenly distributed than

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for other forms of energy. Can energy savings and efficiency gains lead to lasting reductions? While Smil is convinced the highly developed countries could do with 50% less TPES without 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 materials such as cement, steel, aluminium and ammonia. For the energy cost of materials, he displays time series that demonstrate the substantial efficiency increases since the industrial revolution, demonstrates 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 such as working time or quality). In the next chapter on environmental consequences, one finds surprising calculations on power densities (W/m^2 , one of Smil's favourite 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 are related to the combustion of fossil fuels (p. 333). Chapter 12, titled "energetic correlates—complexities of high-energy civilization", starts from long-term decreases of the energy intensity of economies ($\text{MJ}/\text{\$}$) and then joins the debate on using energy (resp. some derivatives such as exergy or emergy) as 'true' measure of value (Odum) or key driver of economic growth (Ayres). As usual, Smil plays out 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." (p. 345f) Chapter 13 then, fortunately (given its number) does not show a grand nor 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 well deserves people's trust as 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". According to him, there were hunters and gatherers also in science, interdependent but a little sceptical of one another. Hunters are the ones that grab for the big theories (and often keep their people hungry); gatherers are the ones that sort out and collect all the evidence that reliably provides the daily food. Smil falls rather on the gatherer's side. But this is exactly why this book deserves its place not only in libraries serving to students of society-nature interaction, but also in private bookshelves so it can be consulted liberally for any of the broad variety of subjects it deals with. 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 Distinguished Professor at the University of Manitoba, Canada)