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Book review

Energy in Nature and Society: General Energetics of Complex Systems, Vaclav Smil. The MIT Press, Cambridge, MA, London, England (2008). 480 pp., approx. US$32, ISBN:978-0-262-19565-2, 978-0-262-69356-9

Vaclav Smil is a prolific writer and knows a lot about agriculture, biology and ecology but not being a physicist by training, he seems to have a particular fascination for energy.

He wrote many books on the issue starting with "General Energetics Energy in the Biosphere and Civilization" (1991), Energy in World History (1994), Energies (1998) and several others. The present book seems to be an ambitious revision of the 1991 book aiming to "produce a comprehensive, systematic, revealing (and hence interdisciplinary and quantitative) treatment of all major aspects of energy in energy and society".

In order to do that in Chapter 1, he tries to define energy, discusses its various forms, laws of thermodynamics and, most importantly, units essential to make—as he does—comparisons and describe broad features of systems. Chapter 2 examines terrestrial energy fluxes (planetary energetics) and Chapter 3 photosynthesis, bioenergtics of primary productions (which I found a difficult chapter to read). From then on he goes into consumer energetics of primary living organisms (Chapter 4), then human energetics (Chapter 5), food production (Chapter 6), preindustrial machinery and infrastructure (Chapter 7), fossil fuels (Chapter 8), fossil fueled civilization (Chapter 9), energy costs (Chapter 10), environmental consequences of fossil-fueled civilizations (chapter 11), complexities of high-energy civilizations (Chapter 12) and challenges ahead (Chapter 13) which is discussion of new technologies.

It is an interesting book to read in which the author displays his mastery of many subjects which frequently specialists fail to grasp.

What impressed me most in the book are the wonderful graphs and figures which convey easily powerful messages. Examples are Fig. 13.8 (p. 383) showing the mismatch of typical power densities of renewable energy conversions and common energy uses in modern societies. Fig. 11.4 (p. 316) showing power densities of anthropogenic releases (such as an automobile) and natural heat releases (such as hurricanes). Fig. 7.9 (p. 194) on the moving a 50 tons statue on a wooden sledge 1800 BCE. Fig. 5.7(b) (p. 177) with the energy cost of walking and running.

My only problems with the book are, in Chapter 1 (The Universal Link, Energetics, Energy and Power), where he tries to explain what energy is, not very successfully, in my view, and in Chapter 3, on photosynthesis.

The Feynman quotation in page 12 is very relevant in this context ("we have no knowledge of what energy is") which is followed by Rose's solution to Feynman's question ("Energy is an abstract concept invented by physical scientists in the nineteenth century"). That is what it is and I wished Smil would elaborate that point. It all boils down to the fact that when a body falls from a given height, due to the gravitational attraction of the Earth, there is a quantity which is the sum of the kinetic energy ($\frac{1}{2}mv^2$) and potential energy (mgx) which remains constant at all times during the fall. The name mechanical energy is given to this sum. Such combination of variables (m—mass, v—velocity and x—height at a given time during the fall) appears naturally when one tries to calculate the "work" (force $\times$ distance) in Newtonian mechanics.

This is true only in gravitational fields and eliminates the possibility of producing mechanical "perpetuum mobile" machines. Later on it has been shown that no "perpetuum mobile" of any kind is possible so the other forms of energy have their equivalent in mechanical energy.

This might indeed be too reductionist, as Smil points out, but gives content to the definition of energy he prefers; "energy as the ability to transforms a system". In simple mechanical system "transportation" means work and "energy is the ability to produce work" or in other words moving things around.

My problem with Chapter 3 on photosynthesis derives from my ignorance. Smil uses too many technical terms (thylakoyd membranes, chloroplants, light-driven enzymatic transfer, Rubisco, C4 pathway, etc.). A glossary would come handy here.

Despite these problems the grand vision given by Smil is enlightening and stimulating and allows us to understand better the world we live in and what we are doing with it, for better or worse.

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