

## Review: Energy in Nature and Society: General Energetics of Complex Systems

By Vaclav Smil

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Smil, Vaclav. *Energy in Nature and Society: General Energetics of Complex Systems*. Cambridge, MA: MIT Press, 2008. 480pp. ISBN: 978-0-262-69356-9. US\$32.00, paper.

As you can expect from the title, in this book Vaclav Smil goes through all imaginable aspects of energy. The announced goal of the book is to produce a comprehensive and systematic treatment of all major aspects of energy in nature and society. The book starts with the evolution of the concepts of energy from Aristotle to Einstein. The next chapter deals with solar radiation and geoenenergetics, the movements of water and air, volcanoes and earthquakes. The following chapters deal with photosynthesis and how animals use energy bonded in plants, with a whole chapter dedicated to humans as energy converters. The next two chapters deal with how humans have harnessed solar energy through farming, using animal and human muscle power, waterwheels and windmills, and by burning wood and crop residues. In the following chapters humans learn to use fossilized stores of solar energy, which have had a profound impact on our societies, on our abilities to travel and produce food and other products. Finally, the book covers the environmental consequences of our ever-increasing use of energy.

Sorry for the exhausting list, but exhausted is very much how I felt after reading the book. Still, I would highly recommend this book, as the effort invested is well-rewarded. Much of the effort needed comes from the broad and complex subject the book is dealing with. It must, however, also be said that Smil makes few concessions to casual readers. The book is lengthy, and the overuse of abbreviations does not make it much shorter (not all abbreviations are included in the list of abbreviations at the end of the book). The book is not for absolute beginners; Smil's 2006 publication *Energy: a Beginner's Guide* is a better starting point. *Energy in Nature and Society* could certainly be used as a reference work on energy, although an encyclopedia would be easier to use for that purpose. Abundant references throughout the book make it a good starting point for all research related to any aspect of energy use.

If Smil's goal is to demonstrate that "[e]verything in the observable universe can be seen, analyzed, and explained in energy terms," then he is successful indeed (p. 365). The last two chapters alone, however, elevate the book over a mere encyclopedia. The preceding dense pages give considerable weight to his belief "...that the key to managing future global energy needs is to break with the current expectation of unrestrained energy use in affluent societies" (p. 384). Instead he calls for a redirection of human ingenuity to the reduction of final uses of energy rather than to the expansion of primary supply. During the twentieth century global energy use rose nearly tenfold and the extraction of fossil fuels 16-fold. The growth of energy use has, however, been much lower than predicted. For example, the global use of oil in 2000 was only around 70 to 80 percent of the forecasted use in the mid-1970s.

According to Smil, "Higher energy use does not guarantee anything except greater environmental burdens." (p. 386). It does not make a country more secure or promote social stability. Smil convincingly shows that quality of life increases as annual energy use per capita increases, but this increase in quality of life is no longer evident after annual per capita use exceeds 100 GJ (gigajoules). This is less than sixty percent of the energy use per capita in Germany in the mid 1990s and only 30 percent of the annual per capita use in the U.S. There is, however, a clear need to double the poor world's rate of use, which is currently about 20 GJ annual per capita.

Smil sees a gradual transition to a civilization running once again on solar radiation and its rapid transformations as the most obvious solution to energy-induced global environmental change. In the much longer run, it is dictated by the limited stores of fossil fuels. He does not put much weight on carbon sequestration, as putting away just 10% of its global flux would require annual handling of a volume equivalent to the current worldwide yearly oil yield. Neither does he believe in an early possibility of a hydrogen-based system as there is no inexpensive way to produce it. Furthermore, he sees the proposals for massive biomass energy schemes as the most regrettable examples of wishful thinking and ignorance of ecosystemic realities, as humans already appropriate 30%-40% of the net primary productivity of the planet as food, feed, fiber, and fuel.

According to Smil: “Our best hope is that we will find the determination to make choices that would confirm the Linnean designation of our species—sapiens.” (p. 388).

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