books

Society’s energy consumption on trial

Kicking the Carbon Habit
Global Warming and the Case for Renewable and Nuclear Energy

William Sweet
Columbia U. Press, New York, 2006. $27.95 (256 pp.).
ISBN 978-0-231-13710-2

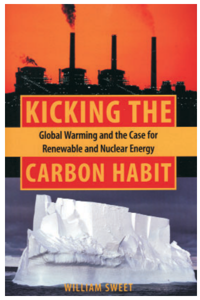
Energy for the Public
The Case for Increased Nuclear Fission Energy

R. Stephen White
BookSurge, Charleston, SC, 2006. $49.95 (310 pp.).
ISBN 978-0-938711-85-8

Reviewed by Andrew C. Kadak

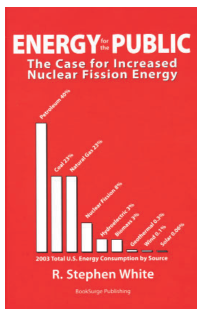
The most fascinating thing about the realities of energy is the difficulties new technologies face when they are intro duced. We have become so dependent on the ease and comfort of fossil fuels oil, and particularly gas that transi tioning to hybrid vehicles or to a hy drogen economy will be the technical challenge of the century.

William Sweet s *Kicking the Carbon Habit: Global Warming and the Case for Renewable and Nuclear Energy* is an in teresting, well written book. It is a must read for anyone who wants a good summary of our current under standing of global warming and the op tions before us. By contrast, *Energy for the Public: The Case for Increased Nuclear Fission Energy* by R. Stephen White is so wide ranging it is hard to summarize. If readers wish to peruse White s book for interesting energy facts and a reality check on the practicalities of alternative energy sources, then the text is certainly worth reading. But if readers are inter ested in how the technologies actually work, they won t find that information in his book.



Sweet, a senior news editor at *IEEE Spectrum*, covers the basics of the formation of coal and oil deposits, climatology, data collection, and analysis and interpretation. He also touches on climate changes over 700 000 years, as evi denced by ice pack field explorations. During that period, the link between Earth s average temperature and car bon dioxide concentrations is remark able. As the concentration of CO_2 varied from its historic average by 100 parts per million by volume, many ice ages and warm periods have occurred as the narrow global average temperature variation was 2 °C to 8 °C. Today we are well outside the historic range of CO_2 concentrations. Never has the concen tration been as high, which may coun teract the naturally expected cyclic cold periods on Earth because of the vari ability of its distance from the Sun.

Sweet presents the information through the eyes of people who have actually done the work, which makes for an interesting nar rative. He is convinced that global warming is the result of the billions of tons of CO_2 and other greenhouse gases that are being emitted annually worldwide. He sees little chance of reducing those emissions unless a serious ef fort is made in all sectors of the economy and overall energy use. The chief culprit is the burning of coal, even though the burning of oil products in the transportation sector contributes almost an equal amount of CO_2 emissions. Unfortunately, the prob lem is complex and thus not easily modeled. Researchers still do not un derstand the climate change process well, which Sweet openly admits.



The author provides an excellent summary of realistic contributions from existing energy sources and of energy options proposed by advocates of re newable energy sources. He proposes that we must wean ourselves off of coal, the major source of CO_2 emissions. He reviews the Kyoto Protocol and concludes that it is possi ble to meet the lofty goals es tablished in 1992. But it will not be easy. He emphasizes that, in addition to renewable energy sources and various energy conservation and effi ciency options, nuclear energy must also play a significant role. For instance, he believes wind is a demonstrated performer but that it will be limited in its application, largely because of enormous energy de mands and wind power s overall lower energy efficiency. Regarding nuclear energy, Sweet says, The most impor tant thing that can be said of nuclear reactors is that they work, in contrast to wouldn t it be nice if renewable alternatives.

White, a professor emeritus of physics at the University of California, Riverside, is even more enthusiastic about the abilities of nuclear energy to contribute to a reduction of greenhouse gases. The purpose of his book, he writes, is to inform the public about its choices on energy policy issues and help it make realistic decisions based on the knowledge of sci ence. What is startling about *Energy for the Public* is that in 310 pages not a single graphic, photograph, or sketch can be found to explain any of the technologies White reviews. Such omissions are significant limitations. But the book does provide some interesting facts about energy, energy sources, and the politics of power. In four parts White establishes energy fundamen tals; introduces a high level review of options for sustainability, reliability, safety, cost, and pollution; delves into the wisdom of deregulation using the California experience as a bad example, with sidebars about Enron and its role in the debacle; and discusses hybrid vehicles, fuel cells, and the hydrogen economy for replacing oil in the trans portation sector.

White sees nuclear energy as an en ergy source to replace fossil fuels, pro vide electricity, produce hydrogen for transportation, and desalinate water

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from the sea. He returns frequently to the theme that nuclear energy is a proven, safe performer that does not emit greenhouse gases such as CO_2. In his review of renewable energy sources, including wind, solar, and biomass, he provides some hard data about their physical limitations to become signifi cant contributors to the world s energy needs. He attempts to base his findings on science, although his foray into the California deregulation debacle is a de parture whose purpose is to warn us about how policy made in the absence of knowledge and understanding can lead to costly failures.

White hopes that nuclear energy will be the transitional energy source, but he does not appear to be optimistic: In his opinion the natural advocates, environ mental organizations and industry, are conflicted for different reasons: The for mer has a history of aversion to nuclear energy; the latter, a heavy reliance on burning coal and other fossil fuels.

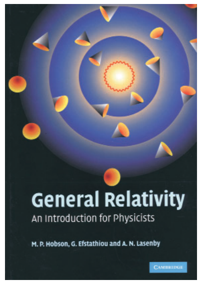
Compared with *Energy for the Public*, Sweet s book is more worrisome. After reading *Kicking the Carbon Habit*, you may become frightened, angry, or sim ply depressed because the problem seems so personally overwhelming, with global warming and climate change being inevitable. The only ques tion for the world might be what form climate change will take. Will Earth get hotter or colder, wetter or drier? Or will all those possibilities occur, depending on where you live? The bottom line conclusion is that we do not know whether cataclysmic climate change is going to happen or when.

Overall, both books offer a sobering, timely message. The global environ mental impact of a business as usual energy strategy is clearly unacceptable. The good news may be that we run out of fossil fuels before we do ir reparable damage to the environment. Some argue that we are very close to that irreparable point now.

General Relativity
An Introduction for Physicists

M. P. Hobson, G. Efstathiou, and A. N. Lasenby
Cambridge U. Press, New York, 2006. $75.00 (572 pp.). ISBN 978-0-521-82951-9

In recent decades, general relativity theory underwent a renaissance from an obscure and rarely taught subject to a standard component of the graduate physics curriculum. The renaissance was fueled by advances in black hole astrophysics, cosmology, and the search for gravity waves, and by theoretical developments at the interface of relativity and quantum theory, in particular black hole evaporation and information loss puzzles. These trends moved general relativ ity from the periphery of mid 20th century physics to the center of early 21st century physics.



Along with increased research activity, many excellent textbooks at various levels have become available. Despite the existence of several excel lent graduate level general relativity texts, *General Relativity: An Introduction for Physicists*, written by University of Cambridge astrophysicists Michael Hobson, George Efstathiou, and An thony Lasenby, is a useful addition to the literature on the subject.

The book s subtitle might lead some to expect a monograph aimed at re search physicists rather than an ap proachable text suitable for advanced undergraduate and beginning graduate students. In British parlance, an intro ductory book for physicists appar ently means one that is aimed at stu dents specializing in physics. In any case, *General Relativity* is written clearly, with most of the arguments worked out in sufficient detail for students to fol low. Numerous exercises are at the end of each chapter, and unlike most recent texts, the factors of Newton s constant G and the speed of light c are written out explicitly. That approach has the down side of leading to more cluttered ex pressions, but it may be helpful to stu dents who are sometimes confused by the $G = c = 1$ units in which masses and times have dimensions of length. The issue of sign conventions in relativity is often a contentious one, with no gener ally accepted convention for the metric signature and the Riemann tensor. The authors adopt the time like metric con vention. I found only a handful of mis prints, which is better than average for a book of this nature.

Compared with other noteworthy recent textbooks on the subject, *General Relativity* is on a somewhat higher level than James Hartle s *Gravity: An Intro duction to Einstein s General Relativity* (Addison Wesley, 2003), which is aimed primarily at undergraduates. The book is more similar in level to Sean Carroll s *Spacetime and Geometry: An Introduction to General Relativity* (Addison Wesley, 2004). Carroll s book has a greater em phasis on the geometrical and quantum aspects of gravity than *General Relativ ity*, which concentrates more on astro physical and cosmological applications. (For a review of the books by Hartle and Carroll, see PHYSICS TODAY, January 2005, page 52.)

Chapter 1 begins with a brief review of special relativ ity, including a discussion of accelerated observers. The next three chapters develop the necessary mathematical formalism of tensor calculus and Riemannian geometry needed for a self contained exposition of general relativity. It is at this point that many authors succumb to the temptation to add digressions that con tribute little to the subsequent discus sion. To their credit, the authors keep the mathematical formalism to the min imum needed to understand the theory and its applications.

Chapters 5 and 6 return to special relativity, in four vector notation, and to the covariant formulation of electro dynamics in flat spacetime. The authors cover the equivalence principle the motivation for a geometrical theory of gravity and the properties of the cur vature tensor in chapter 7. The Einstein equations and their weak field limit are introduced in chapter 8, which also con tains a notable discussion of the rela tionship between the Einstein and the geodesic equations. In electromagnet ism, the Lorentz force law must be pos tulated separately from the Maxwell equations. In general relativity, the equations of motion for test particles the geodesic equations are implicit in the Einstein equations, as was first real ized in a long, complex 1938 paper by Albert Einstein, Leopold Infeld, and Banesh Hoffmann published in *The Annals of Mathematics*. *General Relativity* gives a very simple argument deriving the geodesic equations from stress tensor conservation, a key ingredient in the Einstein equations.

The Schwarzschild solution and ex perimental tests of general relativity are discussed in chapters 9 and 10. The au thors then cover Schwarzschild black holes, relativistic stellar structure, and the Reissner Nordstrom solution in chapters 11 and 12. Chapter 13 contains an especially detailed treatment of the Kerr geometry including its geodesics, and the astrophysics of rotating black holes. Among the points worthy of spe cial mention is the clear discussion of frame dragging.

In chapters 14, 15, and 16, the authors offer extended discussions on cosmol ogy, which is not surprising given that the subject is one of their research spe cialties. Chapter 16 in particular has a detailed discussion of inflationary cos mology, including perturbations from