persecution, he returned with his family to China, where he became a leader of the Chinese space program.

Gainor also tells of the everyday struggles that many early space scientists lived through—poverty and hunger, disease, political persecutions, and fierce competition. Their commitment to space research remained unwavering because of their passion and vision. The book includes lucky mishaps like the one caused by Soviet physicist Andrei Sakharov. Overestimating the weight of the hydrogen bomb, he called for larger and more powerful intercontinental ballistic missiles. It was primarily those larger ICBMs that enabled the Soviets to be the first in space. Another lucky misfortune occurred in 1947 when, during the test-firing of a captured V-2 rocket with a malfunctioning gyroscope, Americans accidentally bombed Mexico. Fortunately, the rocket landed in an old cemetery and caused only minor damage.

I find it amazing that the founding fathers of the space program read and were inspired by the same science-fiction book by Jules Verne, *From the Earth to the Moon* (1865). Equally astonishing is the role that clubs and societies for young rocket and space enthusiasts played. Those organizations turned out many notable space scientists and engineers. The book also suggests that besides the childlike enthusiasm of space scientists, the most powerful motive that took us to space came from the military.

Unfortunately, *To a Distant Day* lacks clear and labeled diagrams of historic technologies such as Goddard's first liquid-fuel rocket and von Braun's V-2 rocket. A comparison of Yuri Gagarin's and Alan Shepard's space capsules would have been another valuable inclusion. The satellite section is brief and incomplete, and Gainor fails to explain the importance of some historic breakthroughs, like the first use of liquid fuel in rockets by Goddard in 1926.

As someone who has been teaching a course on space exploration for many years and has visited most of NASA's space centers, I have found plenty of new and valuable material in *To a Distant Day*, and I regard it as a valuable addition to my library. Its minor omissions aside, I recommend the book to all who wish to know more about the conditions, people, and discoveries between 1890 and 1960 that led to the space age.

Pangratios Papacosta
Columbia College Chicago
Chicago, Illinois

Earth: The Sequel

The Race to Reinvent Energy and Stop Global Warming

Fred Krupp and Miriam Horn
W. W. Norton, New York, 2008.
$24.95 (279 pp.).
ISBN 978-0-393-06690-6

The intertwined problems of energy supply and sustainability provide both a great threat and a great challenge not just to the US but to all nations on Earth. There are many dreamers and schemers, numerous well-posed and difficult scientific problems, and a number of entrepreneurial and financial ideas. The subject overwhelms the popular press, the blogosphere, scientific meetings, and publications ranging from intelligent magazine articles to scandal sheets to books of varying quality.

In *Earth: The Sequel—The Race to Reinvent Energy and Stop Global Warming*, authors Fred Krupp and Miriam Horn take a straightforward tack, essentially arguing that the missing weapon in our approach to the intertwined energy problems is a carbon cap-and-trade system. Effectively, a cap-and-trade system issues permits to emit carbon dioxide. The permits can be

bought and sold: Energy producers who emit a lot of carbon dioxide can purchase permission to do so; producers who cut their emissions below a mandated target can increase their profitability by selling unneeded permits.

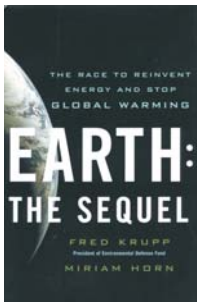
A similar mechanism to address acid rain in the US was designed in the 1980s. The Clean Air Act of 1990 required a 50% cut in total sulfur dioxide emissions, set a permanent cap on those emissions, and ratcheted that cap down over time. Such a plan, say Krupp and Horn, is missing in our approach to the problems of clean energy supply.

Theirs is a good argument, and a persuasive one. Yet the authors don't seem to be aware that a carbon cap-and-trade system is already at work in the US. The Chicago Climate Exchange began operations in 2003 and trades several billion dollars a year in permits without any government participation. Europe also has an extensive cap-and-trade structure, to which the text briefly refers at various places.

Earth: The Sequel is mostly a series of enthusiastic chapters that deal with solar photovoltaics, tidal energy, wave energy, geothermal sources, and other standard mainstays of energy supply. The excitement and the focus on entrepreneurship are evident throughout the book and make it an easy read. It is well written and will appeal to a large audience. The authors make some beautiful comparisons. For example, they point out that preserving half a million acres of tropical rainforest will keep out of the atmosphere "about as much global warming pollution as a 500-megawatt coal plant emits in its entire fifty-year lifetime" and that "depending on the technology and type of coal burned," a coal plant emits roughly 1 ton of carbon dioxide for every kilowatt hour of electricity. Such comparisons are easy to remember.

The book has some serious shortcomings, however. For starters, it is a bit oversimplified: Even in the supply area, wind, solar fuels, and nuclear energy are given short shrift. Conservation, electrochemical storage, and chemical fuels storage are treated only briefly and inadequately.

The real problem, from the viewpoint of a PHYSICS TODAY reader, is the implication that there is no fundamental science left—that the solutions are all just a matter of technology and entrepreneurship and that Silicon Valley is going to bail out the world. The authors foreshadow that perspective on



page 1, stating, "This book is about the kinds of inventors who will stabilize our climate, generate enormous economic growth, and save the planet." Note that they use the word "inventors," not "scientists."

Fortunately, President Obama has clearly recognized that approaching the interface between energy and sustainability requires science and technology, entrepreneurship and fundamental research. Given the distinction of the authors—they are the president and a staffer at the Environmental Defense Fund—the book's narrow focus on entrepreneurship and invention is upsetting.

The book has a few other lapses as well. For example, if fuel cells really worked in the way suggested in the text, they would make energy from nothing, thereby violating the first law of thermodynamics. Page 14 states that capturing solar energy is done either by photovoltaics or by solar thermal processes; the idea of using the Sun to make chemical fuels is ignored, although such technology could get around a number of problems, including those of storage and transmission. Page 4 states that sulfur dioxide is the component of acid rain, but in fact, acid rain is due to sulfur oxides and nitrogen oxides, as is stressed in any elementary chemistry book. And on page 228, they claim that extended mirrors on cars "eat up ten miles per gallon"; if that were true, an average car would spend between a third and a half of its energy pushing its mirrors along the highway.

Sometimes the wording gets out of hand, as in the following sentence: "As an aerospace company, it also knows that any gain in efficiency is worth many times its weight in gold." Yet some sentences are visionary and inspiring: "A kind of frontier spirit animates this new energy world: thirst to venture into the unknown; faith that untapped natural bounty, this time truly limitless, waits just over the horizon . . . ." That enthusiastic dedication, obvious in the book, is one of the two important positive lessons—the other being the importance of cap and trade—that readers might take away.

Earth: The Sequel is reminiscent of some of Thomas Friedman's works, such as his new book, *Hot, Flat, and Crowded: Why We Need a Green Revolution—And How It Can Renew America* (Farrar, Straus, and Giroux, 2008). It will serve as an active antidote to some of the despondent cries about the impossibility of addressing the energy

supply and sustainability problems. But its lacunae serve its readership poorly. One hopes that in a second edition, the authors could be a bit more evenhanded in how they deal with science and address the other aspects (conservation, usage, wind, solar fuels, nuclear, and so forth) that are a part of the energy and sustainability landscape.

Mark A. Ratner
Northwestern University
Evanston, Illinois

new books

materials science

Handbook of Nitride Semiconductors and Devices. Vol. 1: Materials Properties, Physics and Growth. H. Morkoç. Wiley-VCH, Weinheim, Germany, 2008. $360.00 (1257 pp.). ISBN 978-3-527-40837-5

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