are directed to the question of plutonium exposure. The reader may be shocked at the conclusion that 950 000 persons worldwide have been committed to a death from lung cancer from plutonium particulates. This is one of the many challenges Gofman presents to the claims of leaders in the nuclear industry, who will have to come up with some specific data if they are to meet these challenges—general criticisms will not suffice.

While many scientists will disagree with Gofman's very large risk estimates from low-level exposure to ionizing radiation, in most cases they will have difficulty in finding serious flaws in his arguments. The scientific community is sharply divided on this issue. The polarization was emphasized in the BEIR-III (1980) report of the National Research Council: Four committee members expressed dissenting opinions about the cancer coefficients given in the report. This book, however, should be read by proponents of all sides of this issue because it will bring into clearer perspective many concepts and controversies and is certain to help objective scientists understand better the reasons for agreement or disagreement on how the data should be interpreted.

KARL Z. MORGAN
*Appalachian State University*



## A New Prosperity: Building a Sustainable Energy Future (The SERI Solar Conservation Study)

**H. Kelly, K. Gawell**
Brick House, Andover, Mass., 1981. $39.50 cloth, $19.95 paper

## Energy: The Conservation Revolution

**J. H. Gibbons, W. U. Chandler**
Plenum, New York, 1981. $17.50

## Our Energy: Regaining Control

**M. H. Ross, H. Williams**
McGraw-Hill, New York, 1981. $16.95

Energy conservation, once derided as a one-shot spitball against the Goliath of dwindling resources, is now seen to be cost-effective, environmentally benign, and good for the country's balance of trade. It is, unfortunately, still boring. This is not the fault of John Gibbons and William Chandler, authors of *Energy—The Conservation Resolution*, nor of Marc Ross and Robert Williams, who wrote *Our Energy: Regaining Control*, nor even of the multitudinous producers (including Williams and Ross) of *A New Prosperity*, who, coordinated by Henry Kelly and Karl Gawell, turned out this massive SERI Solar Conservation study that met official rejection by the Reagan administration. All of these authors have labored diligently to produce books that will not only convey the good news but will also educate the reader in the art of doing energy analysis. To a large extent they have succeeded. The problem lies in the nature of the subject and in the predeliction of physicists.

Let's face it: People become physicists because they like big ideas, expressed concisely. General relativity, Maxwell's equations—these are the kinds of things that draw us to physics even if we end up doing experimental work in amorphous semiconductors or, heaven forfend, energy analysis. Take nuclear power. There was a big idea—strong forces revealed on a macroscopic level providing limitless energy—and a simple idea, too, as all really big ideas are. Take, even, solar energy: the biosphere as an energy-transfer system. Meet human needs through minor redirection of what is already happening, and be assured that our impact on the Earth will be small and

benign. These big ideas gained popularity, in part, by virtue of the attraction exerted by their simplicity and magnitude. Energy conservation, on the other hand, is as particular and tedious as a triply paned window or a new heat-exchanger alloy.

Given the material at hand, the authors of these volumes have done remarkably well. I will consider their treatment of energy analysis, energy-demand projections, conventional fuels and conservation in buildings; I will then discuss the potential of these books for use in energy courses.

**Energy analysis.** Methodological considerations have given rise to what come closest to "big ideas" for conservation: second-law efficiency and net energy. Second-law efficiency is a measure of how a given use of energy compares with the ideal minimum energy capable of carrying out the task at hand. Ross and Williams use it to build the argument that the savings available through conservation are potentially enormous but point out one weak spot in the second-law approach: Some of our greatest gains come by redefining the task rather than by fine-tuning the current approach (implementation of recycling, for example). Gibbons and Chandler point out the value of second-law analysis as a tool for first-cut estimates and identify a second weak spot: It makes no allowance for economics. In both books the treatment seems cursory and will be hard to follow without prior knowledge of thermodynamics, but this is still better than the SERI report, which failed to treat the topic at all.

Net-energy analysis is ignored in all three books. It is a method that accounts for all the energy embedded in materials, machinery and other inputs to a process. For example, the thermodynamic limit on the energy needed to heat a building includes the energy needed to produce and install any insulation used. The principle is often a useful check on economics. Especially for use in teaching, more complete treatments of both second-law efficiency and net-energy analyses would have been welcome.

**Energy-demand projections.** Despite the demonstrated folly of predicting anything quantitative about the future of systems more complex than, say, small molecules, people persist in doing so. Gibbons and Chandler, presenting an informative dissection of seven influential studies of energy futures, point up two of the most common failings in this arena: a marked tendency towards incomplete or absent documentation and a disturbing sensitivity of projections of energy demand to such highly uncertain matters as the rate of growth of the gross national product or future energy prices. They then commit what might be considered the inverse sin by listing their assumptions and methods in detail but not deriving any projections of future final demand from these. Ross and Williams present a comparable exposure of the demographic, economic and physical errors of some of the silliest projections and construct a "business as usual" projection in a well-structured and detailed presentation. The SERI authors compared their own goals for conservation or solar-induced energy savings to baseline projections "using techniques used by the Energy Information Administration," but their descriptions of—or even references to—these techniques are skimpy, confusing or nonexistent.

**Conventional fuels.** All three books have a common thrust: Using the business-as-usual projections as a starting point, we can conserve large quantities of energy at costs substantially

below current marginal or actual energy prices and alleviate an insidious decline in the supplies on which we now rely. (A "marginal energy price" incorporates the cost of a new supply, such as North Sea oil, rather than a cost averaged over existing supplies.) Such a claim demands that we pay careful attention not only to the costs of conservation, but also to conventional and unconventional resource bases. The SERI report omits conventional sources of energy but covers solar sources in detail. In very similar treatments Ross and Williams and Gibbons and Chandler devote chapters to reserves, costs, environmental impacts and other aspects of coal, gas and oil. They conclude that our current high levels of demand for precious fuels can only continue for another few decades and that impending depletion of conventional supplies will increase extraction costs. Both note the possibility that conventional gas may prove to be a vast and important resource.

**Conservation.** Energy conservation, the core of these books, has the potential to save a large share of our energy expenditures at costs below current fuel prices. All three books discuss how conservation potentials can be estimated, but the differences in emphasis are critical. Consider conservation in climate control. Gibbons and Chandler skip the heat-transfer aspects of energy conservation in buildings altogether and plunge directly into the matching of diminishing economic returns on investments in thermal integrity to the marginal cost of fuel supplies. Ross and Williams start from a slightly stronger technical base by discussing the well-known studies carried out at Twin Rivers by a Princeton group. They follow a microeconomic discussion similar to one of Gibbons and Chandler with a more detailed discussion of such policy matters as the desirability of creating a corps of "house doctors," dealing with the barrier of high initial costs, the poor targeting characteristics of specific (often tax) incentives and the virtues of an energy tax.

The SERI staff used the substantially greater space available to them to cover technical issues, economics and the likely impacts of incentives and other policies in far greater detail than could the other authors. Of special interest in the SERI presentation are "supply curves for conserved energy," which display relationships between national energy savings in a sector due to various technical measures and the marginal costs of saving fuel by the implementation of each measure. These curves offer a convenient way of comparing the relatively well-known costs of saving energy with the unknown and volatile future costs of fuel. The report also covers transportation and industrial energy consumption in much more detail then the other two books.

**Policy recommendations.** All three books indicate their awareness of the political nature of energy problems by including substantial sections of policy recommendations. Some common threads are readily discerned: Inflexible, tightly targeted tax credits have been more trouble than they were worth; energy prices have not reflected the real marginal costs of energy; energy prices do not reflect externalities such as the damage attributable to a poor balance of payments or vulnerability to an embargo; in short, all the authors exhibit faith in the ability of markets to set things right if a few imperfections are corrected. There are two problems with this view. One is that nonmarket forces sometimes work more efficiently than free markets. The authors overlook nonmarket activities that could satisfy their inclinations: None of the current books suggests that the price of oil, clearly at nonmarket levels, should be lowered, even though that would both provide more accurate information and make peoples' lives easier. Pure market forces had little to do with the monopoly-controlled oil price rise and consequent interest in conservation. Rather, these were brought about by institutional and political forces.

The second problem with markets is that conservation involves the aggregation of many minute and detailed remedies. In most institutions, the amounts of money to be saved through conservation, even with six-month payback periods, are usually not large. An uncertainty principle operates in economics: Even in the presence of "perfect" market conditions, a rational decision will not be made if the money involved is too small to be worth the time required for management to think about it. It is doubtful that the freeing of enchained market forces will in itself be sufficient to ensure individual behavior that will ensure society's good.

**Classroom use.** Despite my carping, these are three very valuable books. Serious students of energy matters should consult the SERI study, although "reading" it would be akin to scrubbing floors with a toothbrush. Interested amateurs will read either Gibbons and Chandler or Ross and Williams with interest and probably not be seriously bothered by the omissions noted above. But how will these books serve in energy courses? Although none of them was written to be used as a text, the absence of other suitable material requires an evaluation. The best bets here are probably Ross and Williams and SERI (combined) for courses involving students with the technical fortitude to face up to SERI's tables and Ross and Williams's appendices. Additional material on heat transfer, thermodynamics and the rudiments of engineering economics would also be required. Gibbons and Chandler's cleaner writing style, lower density and sporadic literary allusions will make their book a better choice for less technically oriented courses, but outside reading would be a necessary supplement even here. Although the all-around text may not have been written yet, either of these books could well serve as the focal point of an energy course.

RICHARD LEIGH
*Brookhaven National Laboratory*

## new books

### History, Philosophy, Society & Government

**Ludwig Boltzmann. Man–Physicist–Philosopher.** E. Broda. 169 pp. Ox Bow, Woodbridge, Conn., $22.50

**James Clerk Maxwell: A Biography.** I. Tolstoy. 184 pp. U. of Chicago P., Chicago, 1983. $17.00 cloth, $6.95 paper

**Women Scientists in America: Struggles and Strategies to 1940.** M. W. Rossiter. 439 pp. Johns Hopkins U.P., Baltimore, Md., 1982. $27.50

**A Search for Structure: Selected Essays on Science, Art, and History. C. S. Smith.** 410 pp. MIT Press, Cambridge, Mass., 1983. $15.00 paper

**Risk/Benefit Analysis: The Microwave Case.** N. H. Steneck, ed. 231 pp. San Francisco Press, San Francisco, 1983. $15.00.

**Grosse Physiker and ihre Probleme: Studien zur Geschichte der Physik.** H. J. Treder. 284 pp. Akademie, Berlin, 1983. 68 DM

**What About the Russians—and Nuclear War?** Ground Zero. E. A. Molander, R. C. Molander. 236 pp. Simon & Schuster, New York, 1983. $3.95

**Space, Time and Mechanics: Basic Structures of Physical Theory.** Papers, Colloquium, Munich, May 1979. D. Mayr, G. Sussmann, eds. 245 pp. Reidel (US dist. Kluwer, Boston, 1983). $34.95

**History of Modern Physics, 1800–1950. Project Y: The Los Alamos Story.** D. Hawkins, E. C. Truslow, R. C. Smith. 506 pp. Tomash, Los Angeles, 1983. $46.00

**Scientific Temperaments: Three Lives in Comtemporary Science.** P. J. Hilts. 302 pp. Simon and Schuster, New York, 1983. $15.95

**Echoes of the Ancient Skies: The Astronomy of Lost Civilizations.** E. C. Krupp. 386 pp. Harper & Row, New York, 1983. $19.95

**La Gestion des Projets Spatiaux.** Proceedings, Conference, May 1982. J. Muller, sec. 872 pp. Cepadues, Toulouse, France, 1982. 350 FF