BOOK REVIEWS

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Nuclear Power: Both Sides

Editors	Michio Kaku and Jennifer Trainer
Publisher	W. W. Norton and Company, Inc., New York (1982)
Pages	267
Price	$14.95
Reviewer	Allan T. Mense

The book's stated purpose is to present "the best arguments for and against the most controversial technology" of our day, i.e., nuclear fission power. In this reviewer's opinion, the authors have in large measure succeeded. There are no other books, to the reviewer's knowledge, that present both sides of the issue in as compact and clearly understandable a format as is done in this book. It is a "must read" for those who wish to thoughtfully enter into the nuclear debate.

The book is divided into seven chapters. They are A Brief History; Radiation; Reactor Safety; Nuclear Waste Disposal; Economics; Beyond Light-Water Reactors; and Where Do We Go From Here? In each chapter, both pro- and antinuclear persons wrote subchapters espousing their views. Of particular interest to fusion buffs is the chapter, "Beyond Light-Water Reactors," which has a section on fusion written by Stephen O. Dean, who is the chief executive officer of Fusion Power Associates and director of Fusion Energy Development for Science Applications Inc. I must admit at the outset to having a pro-nuclear bias. One of the book's editors (Kaku) is a well-known leader in the antinuclear movement. I was thus sensitive to even the slightest amount of "antinuclear" bias in editing. With only a couple of minor exceptions, I essentially found none.

In addition to providing a capsule of thought on the nuclear issue, the book is important in allowing the reader to understand some of the underlying philosophies of those who are in the anti- and pro-nuclear movements. In general, the nuclear advocates tried to unemotionalize the nuclear debate, stated concern but without undue alarm, and suggested proceeding with the business of supplying the world's energy. This calmness, of course, aggravates the hell out of the staunch antinuclear factions, yet even some of the antinuclear people appear to be calling for dialogue. I believe this book has helped that dialogue. The antinuclear authors, who by and large did play to the emotionalism of the readers, did provide some strong factual cases that the pro-nuclear community must solve before nuclear is a viable option. The most poignant sting came from Ralph Nader in attacking nuclear power plant economics.

Brief reviews of the chapters follow (subchapter titles are indicated in parentheses).

Chapter 1 presents a fine historical introduction to the nuclear power evolution by Boyd Norton, a former U.S. Atomic Energy Commission reactor physicist. It sets the stage in only $10\frac{1}{2}$ pages.

Chapter 2 deals with ionizing radiation. Four authors wrote subchapters. Karl Z. Morgan, former director of the Health Physics Division at the Oak Ridge National Laboratory (ORNL) ("Understanding the Risks") and John W. Goffman, former associate director of the Lawrence Livermore National Laboratory (1963 to 1969) and now chairman of a San Francisco based antinuclear group ("George Orwell Understated the Case"), both present antinuclear views. Allen Brodsky, senior health physicist at the U.S. Nuclear Regulatory Commission (NRC) and editor of the *Handbook of Radiation Measurement and Protection* ("Protecting the Public"), and Bernard L. Cohen, professor of high-energy physics at the University of Pittsburgh and chairman of the American Nuclear Society Division of Environmental Sciences ("Exaggerating the Risks"), both take the pro-nuclear case. The bottom line in this chapter is that the pro-nuclear group, using radiation effect data proposed by the Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences, contend that concerns for the low-level ionizing radiation have been exaggerated, and that, when carefully controlled tests have been run, radiation from nuclear power plants is only a small factor in producing adverse health effects. The antinuclear people agree that small doses produce small effects but disagree with the conclusions of the BEIR committee on such substantive facts as the number of person-rems per cancer death. The industry-accepted number would be in the range of 1 death per 5000 to 10 000 person-rems; Goffman would contend (on data that were certainly not refuted in the book) that the correct number would be 1 death per 1000 person-rems. Some critics even pick the number lower, say 1 death per 100 person-rems. Needless to say, when one realizes that most of the fatalities predicted after a Class 9 (worst case) accident are due to low-level exposure and latent cancer effects years after the accident, the magnitude of these low-level numbers can make or break your case.

Chapter 3 deals with reactor safety. Here, Anthony Nero, a nuclear physicist with the Energy and Environment Division of the Lawrence Berkeley National Laboratory, argues that nuclear power is still the safest, least environmentally harmful source of base-station power, particularly since the institution of new measures after the Three Mile Island accident. Jan Beyea, staff physicist for the National Audubon Society, makes the other case. His work on fission product dispersal after a reactor meltdown accident has led him to the conclusion that reactors must be made much safer because present day safety equipment was added as an afterthought.

Chapter 4 covers nuclear waste disposal. Fred Donath, former head of the Geology Department at the University of Illinois ("No Technical Barriers"), presents the point of view widely accepted by the nuclear community: There are no major technical problems that should prohibit the safe disposal of reactor waste. He does, however, grant that one must use mathematical models based on short time-scale experiments and then extrapolate to much larger geologic time frames. Robert Pohl, a solid-state physicist at Cornell University, presents the view that one must be careful in accepting present day assurances because history has taught us that, each time appropriate governing bodies have made assurances as to the adequacy of waste disposal technology, they have been wrong.

Chapter 5 deals with power plant economics. It presents two hard-hitting antinuclear articles, one by Ralph Nader and Richard Pollock (a former director of Nader's Critical Mass Energy Project) and the other by Vince Taylor, staff economist for the Union of Concerned Scientists. In addition, it provides two cautiously optimistic pro-nuclear articles, one by Tony Velocci, Jr., a senior editor at *Nation's Business* magazine, and the second by Alan Manne, professor of operations research at Stanford University (SU), and Richard Richels, technical manager for the Electric Power Research Institute. Without trying to trivialize the arguments presented, Nader et al. argue that the nuclear industry (including the utilities) has brought about the demise of nuclear energy by not being able to manage, build, and maintain complex nuclear power plants in an economically satisfactory manner. The boards of directors of utilities have lost confidence in nuclear energy because they know that most of the cost increases for nuclear energy can be traced to poor industry production, control, and management. It cannot, in general, be blamed on the NRC or interveners. The pro-nuclear forces contend that utility economics, in general, is poor, mostly because many utilities have been regulated to death by their "politically appointed" public utility commissions (PUCs) and the PUC's constant insistence on not allowing construction costs in the rate base. These overall economics problems, coupled with hyperinflation, have made all large capital investments look bad. Nuclear is very capital intensive and, thus, suffers, but nuclear should not be singled out as being uniquely guilty of the crime of mismanagement.

Chapter 6 discusses what is in the energy future after light water reactors (LWRs). Here, Amory Lovins and his wife lay out the so-called Soft Energy Path, which they contend is mutually exclusive to any type of centralized base station power. The Lovins' strong point is their plea for people to use the energy source that best fits the required energy use. Short of factors that might affect national security and would therefore be overriding, their plea makes a great deal of sense and will hopefully govern more individual/industrial actions in energy usage. The Lovins go on to argue that we, in the United States, can live just as well if not better on only half of our present energy per capita usage. They presume, using specially selected examples, that this can be accomplished with a minimum of societal disruption, and for a cost the citizens will be willing to pay. This is refuted somewhat by the second antinuclear (actually pro-solar) author, Modesto Maidigue, who is an associate professor of engineering management at SU and a co-author of *Energy Future*, a part of the Harvard Business School Energy Project. Maidigue points out ("Golden Decade for Solar Energy") that despite solar's tantalizing advantages, one of the main disadvantages of on-site solar energy is that the individual user must assume increased management responsibility for the system. He quotes one homeowner as saying, "Solar energy is a hassle." In addition, Maidigue indicates that solar capital costs must come down considerably, even when one takes into account federal and state tax subsidies. (The Lovins would argue that, primarily through better conservation measures, one can reduce energy consumption to the level where the increased energy cost would be offset.) Maidigue says, "We must do two things if we wish to diffuse solar energy on a broad basis: First, we must find innovative ways to make solar energy more competitive. Materials costs . . . account for 80 percent of the cost of a solar collector system," and "Second, and most important, we must encourage business, especially big business, to complete the solar technology system." Maidigue and the Lovins both agree that institutional barriers appear to be one of the largest single problems to overcome if soft energy paths are to prevail.

Steve Dean does an excellent job of describing the promise and potential of fusion power, both inertial and magnetic. Unfortunately, in this chapter's introduction, the editors chose to quote David Rose of the Massachusetts Institute of Technology as an illustrative opinion of the status of fusion research. The quote was, "Designing a nuclear fusion reactor . . . is a little like planning to reach heaven; theories abound on how to do it, and many people are trying, but no one alive has ever succeeded." While the reviewer would contend that no scientist in the fusion community would fight with Rose on this statement, the statement nevertheless reflects more the view that fusion is a joke, and that the 2500 U.S. scientists working on fusion are dreamers with little credible data to build on. The real optimism that is shared by the fusion community is, however, brought out by Dean.

Finally, Nobel Laureate Hans Bethe and Robert Avery, who is the director of the Reactor Analysis and Safety Division at the Argonne National Laboratory, outline the case for the liquid-metal fast breeder reactor (LMFBR). They restate that with breeder reactors "no major scientific or economic developments, such as those required for solar electric and fusion power, are necessary." On breeder reactor safety, they note that the lower coolant pressures ($\sim$1 atm) and good thermal properties of liquid-metal coolants should make the LMFBR safer than LWRs. In addition, as uranium fuel prices rise (they need to be \$120/lb for breeders to pay; today uranium fuel costs \$25 to 30/lb), the economics of breeders should look better and better.

The final chapter includes an essay by Alvin Weinberg, director of the Institute for Energy Analysis in Oak Ridge, Tennessee, entitled simply "The Future of Nuclear Energy" where he notes that prudence dictates erring on the side of having available more energy than we could use than on the side of not having enough. He believes that there must be some technical improvements in nuclear power if it is to be accepted. He also expresses the *hope* that continued research will show that low-level radiation effects are less harmful than what the "linear hypothesis" now implies. Following Weinberg is an article by David Dellinger, a long-time pacifist but one-time pro-nuclear power advocate who now believes nuclear power is unacceptable. His appeal is that the government, as well as "big business," has always lied to the masses about many things, nuclear power being a prime example. Dellinger's theme is that unless the power is in the hands of the people, people will not have the information to judge technology, and nuclear power is a symptom of an undemocratic political disease. The final author, Bertram Wolf, vice president and general manager of General Electric Company's nuclear energy division, writes on what he believes to be the antinuclear movements' "hidden agenda." He indicates that three such hidden agendas, which practitioners of the anti-nuclear movement many times have, are

1. a general distrust of any society that has an abundant energy supply
2. that society should be forced to alter and reorient itself to minimize energy use
3. general dissatisfaction with our present social and economic structure and the suggestion that energy should be used as a means for societal change even though these changes may not be directly connected with energy problems or needs.

To illustrate an example of the first hidden agenda, Wolf quotes Amory Lovins:

"In fact, giving society cheap, abundant energy at this point would be the equivalent of giving an idiot child a machine gun."

and

" . . . it'd be a little short of disastrous for us to discover a source of clean, cheap, abundant energy because of what we would do with it."

The epilogue, by the editors, does an *excellent job* of summarizing the issues covered throughout the book, and bringing together some of the important choices that must be made.

This book is highly recommended.

Allan T. Mense is currently a senior scientist with the Fusion Science Department, McDonnell Douglas Astronautics Company (MDAC), and adjunct associate professor of physics at the University of Missouri-St. Louis. Prior to joining MDAC, Mense spent several years on the staff of the Science & Technology Committee in the U.S. House of Representatives, where much of this nuclear power debate took place. Mense also has worked at ORNL and, prior to that, received his PhD in nuclear engineering (plasma physics) from the University of Wisconsin-Madison.

Nuclear Energy Synergetics: An Introduction to Conceptual Models of Integrated Nuclear Energy Systems

Authors	A. A. Harms and M. Heindler
Publisher	Plenum Press, New York (1982)
Pages	238
Price	$35.00
Reviewer	Ehud Greenspan

As stated in its Preface, "this book is intended as an introductory exposition of those nuclear energy systems concepts which are characterized by an integrated utilization of complementary nuclear processes. Basic to such systems is the notion of synergism, which herein implies the cooperative interaction of selected nuclear reactions and system components so as to provide overall advantages not possible otherwise."

Three primary nuclear reactions are considered: fission, fusion, and spallation reactions. The latter two are to be supplemented by other neutron multiplying [primarily $(n,2n)$] reactions. These reactions provide the basis for different types of power-generating and/or fuel-producing devices, including fission reactors, fusion-fission hybrid reactors, fusion breeders, and accelerator breeders (in which protons or deuterons accelerated to gigaelectron volt energies impinge on a high-Z target to release, via spallation and possible fission reactions, dozens of neutrons per beam ion).

The incentive for the synergetic approach to nuclear energy is the development of fuel-unlimited nuclear energy economy in a way enabling to take the utmost benefit of the different types of nuclear reactions and reactors thus, hopefully, providing for a nuclear energy economy more attractive than possible otherwise. Whereas conventional fission reactors are very efficient power sources (in the sense that they require a very low fraction of their generated energy to be recirculated) and economical, they are neutron and, hence, fissile fuel limited. Fast breeder reactors are expected to have a better neutron economy, but their doubling time might limit their rate of deployment, and their economic viability is still questionable. Fusion and spallation reactors, on the other hand, can provide an ample surplus of neutrons (as measured, for example, in terms of the number of surplus neutrons generated per given amount of thermal energy that need be removed), which can be efficiently used for fissile fuel production and nuclear waste transmutations. The latter function could benefit also from the relatively high energy of the fusion and spallation neutrons. However, spallation reactors as well as low-energy-gain fusion reactors will require a significant investment of electrical power for their operation. Thus, a proper mix of energy-rich fission reactors and neutron-rich fusion or accelerator breeders might provide for an energy system more attractive than possible with fission-only power reactors.

Treated in the book in length are three types of energy systems:

1. symbiosis of accelerator breeders and fission reactors (Chaps. 4 and 5, a total of 46 pages)