Prospects For Sustainable Energy

The evidence is becoming ever clearer that continued use of fossil fuels as the world's dominant energy supply is damaging the environment and causing changes in global climate patterns. Fossil fuels are also a finite resource, and the current situation is, therefore, unsustainable: future use of alternative methods of energy supply is inescapable. The promise of renewable energy can only be realized through significant investments in research and development on alternative, sustainable technologies.

Prospects for Sustainable Energy explores the historical origins, technical features, marketability, and environmental impacts of the complete range of alternative sustainable energy technologies: solar, biomass, wind, hydropower, geothermal power, ocean energy sources, solar-derived hydrogen fuel, and the energy storage technologies necessary to operate them competitively. Arguments for and against implementation of each option are addressed, and the book makes a technological and economic assessment of the market readiness of these technologies and the prospects of each for reaching a competitive status.

The aim of this book is to inform policy analysts and decision makers of the options available for sustainable energy production. The book is written to be accessible to an audience from a broad range of backgrounds and scientific training. It will also be a valuable supplementary text for advanced courses in environmental studies, energy economics and policy, and engineering.

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For Bernice

Prospects for Sustainable Energy

A Critical Assessment

Edward S. Cassedy

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Preface

The purpose of this book is to assess the prospects of producing significant amounts of the world's energy needs from renewable resources – alternatives to fossil fuels. The assessments will be technological, economic, and social in nature.

The underlying basis for judgment on my part, in all three areas, is my experience in a lifetime of research, engineering, and teaching, having been a member of the faculty in electrical engineering at the Polytechnic University for 35 years and a staff member in two different R&D laboratories for almost 10 years before that.

In recent years, I have participated in engineering/economic projects to examine energy storage and solar heat for industrial use. I also, during the years of the "energy crisis", taught a course to graduate engineering and management students in energy policy issues. Finally, in the 1990s, I have taught graduate students and guided doctoral research in electric power system economics and planning.

There is, moreover, another experience of my recent years which has helped to shape this book. This was the teaching and writing leading to the publication of *Introduction to Energy – Resources, Technology and Society*, Cambridge University Press, 1st edn, 1990, 2nd edn, 1998; this was co-authored with P. Z. Grossman (now a professor of economics at Butler University). It was written by us as part of a new academic program, one of several across the country called Science, Technology and Society (STS) programs, and was dedicated to fostering *technological literacy* amongst students not majoring in any branch of science or engineering. The objective for these students was to lay a foundation of understanding in science sufficient for them to engage in critical analysis of the problems of our technological world.

I found from this experience – in short – that the two worlds of C. P. Snow did not have to be entirely separate. This was then the starting point for me to presume that I could write a book such as the present one, addressing technical issues for an audience that would be technologically literate but not necessarily technically expert. I, therefore, gained the confidence that the critical aspects of the prospects for alternative energy production could be conveyed to economists, business people, and policy analysts who are technologically literate but do not have the technical expertise of science or engineering training.

My experience in academic science and engineering includes another realm besides that of technological understanding, however, one that is well recognized as influencing the processes of scientific progress and technological change. This is the realm of social behavior, as it appears in

the world of academia, research, and technology, molding the outcomes from that world. It has been during the course of the R&D efforts that I first observed many of the phenomena of social behavior that are summarized in Chapter 11 (Research and development) and Appendix C (The conduct and management of research and development). Also, many of the social conditioning aspects of doctoral training mentioned in the latter chapter have been evident at close hand in the course of administering the graduate program in electrical engineering at the University.

In Appendix C, I have used these experiences and observations as a guide to search the literature of the behavioral sciences – mostly, in the sociology and history of science. The behavioral aspects of research and development are important in the assessment of prospects of new technologies in two major areas, in my estimation. In popular terms, I would call these "group think" and "boosterism." Regarding the first, the behavioral literature which I have cited gives ample evidence of the "corporate/consensual" nature of the scientific establishment and how this tends to channel the paths of inquiry in scientific disciplines. Regarding the second, my way of dealing with the seemingly inevitable promotional tendencies in R&D literature has been simply to omit it from my text whenever it seems to crop up in my references. As I explain in the Introduction, my practice will be to cite the present status of each technology and what the prospects for progress are *but* pointedly to avoid repeating the optimistic projections of those who have a stake in those outcomes.

This all may not win favor in some quarters, nor will the critical nature of some of my assessments in some cases. It has long been my feeling, however, that the needs of public officials and private investors are ill served by the technological optimism and, often, out and out boosterism that the technical community feeds them about new technologies. Even though most of these promising messages are not blatant distortions or patently self serving, being more the product of the culture of the technical community, they are still misleading to those without expertise among policy makers, investment advisors, and the public at large. I take a position along with Ken Karas, Past President of the American Wind Energy Association, who cautioned his wind-industry colleagues about issuing overly optimistic projections for their technology. I favor sustainable technologies and advocate their development, but I shrink from overly optimistic advocacy. In fact, that is what this book is all about. My sense is that independent, realistic assessment, rather than boosterism, does a better service for the continued support of R&D programs for sustainable energy technologies.

I am indebted to several people for their comments and guidance in earlier drafts of this book, including Peter Meier (Idea, Inc., Washington, DC), Peg Reese and Victor Rezendes (US General Accounting Office, Washington, DC), and my former colleague Peter Grossman (now at Butler University, Indianapolis, IN). Certain anonymous reviewers also added measurably to the quality of the book. My editor, Matt Lloyd, has been of immeasurable help with his advice and support of this effort. I offer my thanks to Ms Carletta Lino, of Polytechnic University, who typed the

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