

The Science of Renewable Energy



Frank Spellman and Revonna Bieber



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The Science of Renewable Energy

For Lyn Hunter

Preface

Studying renewable energy without science is analogous to attempting to cook without being able to read a recipe or to measure ingredients. Moreover, studying renewable energy through science affords us the opportunity not only to grasp the pressing need for renewable energy but also to evaluate and define the complicated task involved in developing viable energy sources for the future. For future energy needs, there is no question or doubt that we are facing an international crisis of unprecedented proportion. We are headed for a train wreck—the end of affordable and accessible petroleum products and the resulting economic and political impact. Keep in mind that we need to replace liquid hydrocarbon fuels because the wells are almost dry, but also remember that we must clean up the environment as well. Production of the reliable, renewable energy that is so essential to us should not destroy or further pollute our fragile environment.

Even though peak oil is here and hydrocarbon energy resources will soon be strained to the limit, and even though we recognize the disastrous, oncoming train wreck of world economies collapsing, we need to follow Adrienne Rich's* perfect words and “dive into the wreck.” Simply, a substantial and reliable supply of renewable energy is the wreck preventer we need; simply by pursuing emerging technologies that include making oil or energy from our usual discards—garbage, algae, plastics, sewage, agricultural and forestry biomass and waste—to power fuel cells and full-sized, plug-in diesel hybrid SUVs, we can minimize or even avoid the damage this approaching train wreck is certain to cause if we continue on our present course. The development of these emerging technologies must be accompanied by advancements in solar, wind, and ocean technologies.

Many of us have come to realize that we pay a price (sometimes a high price) for what we call the “good life.” Consumption of the world's resources makes us all at least partially responsible for the shortages and the resulting environmental pollution. It is a matter of proven record that pollution and its ramifications are the inevitable byproducts of a good life maintained by fossil fuels. Fuel shortages and pollution due to the use of fossil fuel cannot be attributed to any one individual. To reduce fuel shortages and its harmful effects, we must band together as an informed, knowledgeable electorate and pressure our elected decision-makers to manage the problem now, for the future. It is imperative that we replace fossil fuels with clean and efficient renewable energy. We must quiet that vocal minority of doomsayers and naysayers who claim that the transition from our current fossil fuel-based economy to one that is based entirely on renewable energy would be too costly and impractical. This text was not written to silence these doubting Thomases, but instead to make their arguments hollow, and at best, moot. Even as individuals we can have an impact on the quest to develop renewable energy sources, to replace dwindling supplies of crude oil, and to preserve and repair the environment. The concepts and guidelines provided in this text will equip the reader with the critical scientific rationale required to make decisions directly affecting our quest for renewable energy sources—decisions that not only make sense but also work to preserve the environment around us.

Throughout this text, we present common-sense approaches and practical (and sometimes poetic) examples. Because this is a science text, we have adhered to scientific principles, models, and observations; however, you need not be a scientist to understand the principles and concepts we present—we go easy on the hard math and science and present the material in a user-friendly manner. You do need an open mind, though, as well as a love of the challenge of wading through the muck, an ability to decipher problems, and the patience to answer questions relevant to each topic presented. We weave real-life situations throughout the fabric of this text and present them in straightforward, plain English to equip you with the facts, knowledge, and information necessary to understand the complex issues and to make your own informed decisions.

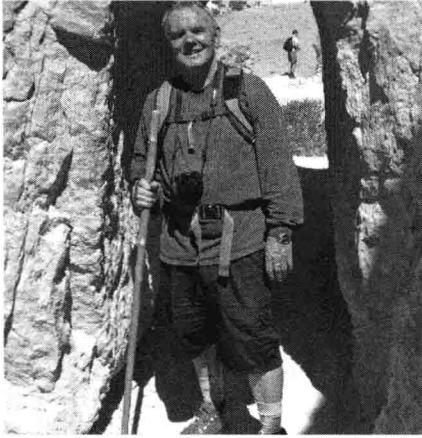
* Rich, A., *Diving into the Wreck*, Norton, New York, 1994.

As a companion text to *The Science of Water*, *The Science of Air*, and *The Science of Environmental Pollution*, *The Science of Renewable Energy* follows the same proven format used in the other best-selling texts. Like its forerunners, this text is not an answer book. Instead, it is designed to stimulate thought. Although possible solutions to specific renewable energy questions are provided, we also point out the disadvantages and hurdles that must be overcome to make renewable energy a viable alternative to fossil fuels. Our goal is to provide a framework of principles on which to build an understanding of the complexities of substituting renewables for fossil fuels.

The Science of Renewable Energy is designed for a wide range of diverse student backgrounds. The text focuses on renewable energy derived from natural processes that replenish constantly: the sun, wind, and water (tides and waves); geothermal resources; biomass; hydroelectricity; biofuels; and hydrogen fuel cells. We explore ways to derive and process energy while limiting or abolishing pollution of the atmosphere, of surface and groundwater, and of soil (the three environmental media), all critical to our very survival. Because renewable energy and pollution prevention are real-world problems, it logically follows that we can solve these problems by using real-world methods—that's what *The Science of Renewable Energy* is all about.

Frank R. Spellman
Revonna M. Bieber

Authors



Frank R. Spellman, PhD, is a retired assistant professor of environmental health at Old Dominion University, Norfolk, Virginia, and author of more than 70 books covering topics ranging from concentrated animal feeding operations (CAFOs) to all areas of environmental science and occupational health. Many of his texts are readily available online, and several have been adopted for classroom use at major universities throughout the United States, Canada, Europe, and Russia; two have been translated into Spanish for South American markets. Dr. Spellman has been cited in more than 400 publications. He serves as a professional expert witness for three law groups and as an incident/accident investigator for the U.S. Department of Justice and a northern Virginia law firm. In addition, he consults on homeland security

vulnerability assessments for critical infrastructures including water/wastewater facilities nationwide and conducts pre-Occupational Safety and Health Administration (OSHA)/Environmental Protection Agency (EPA) audits throughout the country. Dr. Spellman receives frequent requests to co-author with well-recognized experts in several scientific fields; for example, he is a contributing author for the prestigious text *The Engineering Handbook*, 2nd ed. (CRC Press). Dr. Spellman lectures on sewage treatment, water treatment, and homeland security and health and safety topics throughout the country and teaches water/wastewater operator short courses at Virginia Tech (Blacksburg, Virginia). He holds a BA in public administration, a BS in business management, an MBA, and an MS and PhD in environmental engineering.



Revonna M Bieber is currently working as a staff industrial hygienist in Norfolk, Virginia. She holds an AAS in radiography, a BS in biology, and a MS and MPH in environmental health and safety. She has worked with Dr. Spellman on various publications.

“We won’t know we have too many cars—until we have too many cars.”

—**Eugene Odum, U.S. ecologist (2001)**

The eminent ecologist, Eugene Odum, is probably correct in his assertion about knowing when we have too many cars only after that day actually arrives. A more pressing concern is if we acknowledge that a liquid fuel crisis exists only after the fuel taps run dry.

—**Frank R. Spellman (2011)**

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