

# ALTERNATIVE ENERGY: SOURCES AND SYSTEMS

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*Donald Steeby*



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**Alternative Energy: Sources  
and Systems**  
**Donald Steeby**

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## DEDICATION

*To my wife, Diane, for being the love of my life,  
my constant inspiration, and for believing  
in me through all these years.*

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## ACKNOWLEDGMENTS

I would like to thank the following people who helped make this book possible: To my wife Diane, daughter Erin, and brother Jerry for their contributions; to Mike Feutz, Ph.D., Ferris State University, for writing the Foreword and helping me review my subject matter; to Amy Kavanaugh, Ph.D., Ferris State University, for getting me through my master's degree; to Geoff Moffat for helping me with zoning issues; to Mitch LeClaire and Mike Lafferty for getting me interested in geothermal; as well as the following people and organizations for their support, inspiration, and contributions:

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## FOREWORD

I first heard of Don Steeby when I began teaching at Ferris State University in 1998. He was the student, I was told, who wrote a software program that our students used to size ground loops for geothermal heat pump systems. His software was successful enough to sell in the market, but it also played a significant role at Ferris. Students in the Heating, Ventilation, and Air Conditioning (HVAC) Engineering Technology program used his software to size ground loops as part of their first-place submissions in a number of international mechanical system selection and design competitions sponsored annually by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). As you will see, this book is similar to the software that Don wrote. Both are symbolic of his background and career: technical yet down to earth. Don draws on his experiences in life, from the mechanical know-how and connection he made with the environment as a farm boy, to the technical expertise he gained in the HVAC industry and the education he received from a community college and two universities.

Growing up on a dairy farm in west Michigan taught Don to be self-dependent, as his family usually fixed things themselves. Don was milking cows by the time he was 10 and learned about machinery first hand as a young boy, when he found he liked to take things apart to find out how they worked. His interest in agriculture led him to the Institute of Agricultural Technology at Michigan State University. After graduating in 1980, Don found a poor farming economy and turned to other jobs. While working as an electrician he decided that the skilled trades suited him well, so he returned to school part time in the fall of 1985, enrolling in the HVAC program at Grand Rapids Community College. By the time he graduated with his associate degree in 1992, Don had worked his way up to national sales manager, selling gas direct-fired make-up air units for a subsidiary of Rapid Engineering.

Though he had established a successful career, Don wanted to learn more. In the fall of 1994, with a wife, two kids, and a mortgage, he quit his job and went back to school full time to earn his bachelor's degree in HVAC Engineering Technology from Ferris State University. It was at Ferris where Don's passion for learning and down-on-the-farm know-how prompted two of his professors to ask him to write the geothermal software. Upon graduation, his new degree led to a position with the Honeywell Corporation. Controls engineers are called upon to solve complex problems and do so by combining systems thinking with systematic troubleshooting techniques. Because they must know all aspects of countless types of mechanical systems from both the design and operation perspectives, the good ones are among the most knowledgeable people in the HVAC industry. Don was one of the good ones and moved up through the ranks.

While he was with Honeywell, I asked Don to teach as an adjunct for us at Ferris State. He accepted the new challenge eagerly. He did so well that in 2002, his students won the same ASHRAE international HVAC system design competition that his software had helped other students win in earlier years. Teaching sparked a

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new interest for Don. In fact, we tried to hire him as a full-time instructor, but he turned us down. Though teaching at his alma mater represented a tempting opportunity, the campus was too far of a drive and strong ties to his community and the family farm did not allow him to consider relocating.

Don also taught as an adjunct at Grand Rapids Community College, another of his alma maters, and located much closer to his home. When a full-time position became available in 2007, he jumped at the opportunity. It was no surprise to me when he was selected as the successful candidate and left a promising job in the HVAC industry to begin a new chapter in his career. True to form, Don took the next step in his education with his new career, and I had the pleasure of serving on his thesis committee when he earned his Master's of Science in Career and Technical Education from Ferris State University in the spring of 2010.

This book is an extension of the research Don completed for his thesis. Much of what you read is a collection of the knowledge that he acquired through his graduate work. But it is more than that. It is a statement of his passion for alternate energy, for learning, and for sharing knowledge. I am reminded of Armstrong International, a family-owned American manufacturer of high-quality products for the steam, air, and hot water industries. Armstrong operates by the motto, "knowledge not shared is energy wasted." That motto has multiple meanings when applied to this book. The energy sources that Don writes of are available and abundant, but like the knowledge in the Armstrong motto, are largely wasted until we deploy methods to harvest them. And the work that Don has done to compile information about the various forms and uses of alternate energy would be wasted if he did not share the knowledge he has gained with you.

This book, written in an easy-to-understand manner, serves as a primer for those who wish to learn about energy alternatives and applications. What follows is a comprehensive work, as Don provides practical, historical, and technical perspectives, allowing the reader to learn about all aspects of each form of alternative energy solutions. This is not an engineering text. It is a thorough introduction to and discussion of solar, wind, geothermal, biomass, and future energy sources (fuel cells and combined heat and power [CHP] systems). Without additional training and/or expertise, the reader should not expect to be prepared to design, install, or maintain an alternative energy system. But the reader will come away with a better understanding of the background, application, feasibility, economics, efficiency, and technology behind these five energy sources.

Don has gone beyond his goal to "outline the fundamental workings of various types of alternative energy equipment and show how these types of equipment are applied, installed, serviced, and maintained for today's marketplace." He has infused his passion and expertise into the pages that follow. From his farm boy know-how to his master's degree in career and technical education, Don has created a resource that you will find informative, practical, and useful.

Michael J. Feutz, Ph.D., LEED AP  
*Professor, HVAC*  
*Ferris State University*

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## PREFACE

The dictionary defines the word *energy* as “any source of useable power” and the words *alternative energy* as “energy that can replace or supplement traditional fossil fuel sources.” Traditional energy sources such as electricity, natural gas, and fuel oil have been reliable life-sources in society that have created lighting for work, heating for homes, and have made the world a more comfortable place. Today, however, with traditional energy in short supply and in great demand, it is understandable that there is a desire to find alternative sources that will meet the growing needs of our society. The intent of this book is to not only assist the reader in developing a deeper understanding of alternative energy, but also to assist in satisfying the demand and desire for new reference material that has been created by the nation’s thirst for clean, abundant energy. The purpose of this book is to enhance the development of practical applications for alternative energy and its equipment within the climate-control industry. There are numerous HVAC installation and service companies throughout the United States who are interested in entering into the alternative energy market. In order to be prepared for this market, these companies will require that their personnel be properly trained in areas of alternative energy in order to become competent and qualified technicians. This book will fill a void that currently exists between basic information on alternative energy and the higher level, more intellectual material that is suited toward the engineering and development of alternative energy systems.

The usage of this book is directed toward the following entities: HVAC contractors and energy contractors who are seeking to educate their workforce in the ways of alternative energy, students who wish to further their education in the use of alternative energy systems, and homeowners and business owners who are seeking alternative ways in which to reduce their energy costs. There is a real need for a comprehensive book that bridges the void between the simplistic, do-it-yourself type manual and the graduate level engineer textbook that tends to focus on the development and analysis of these types of systems. The research that was compiled for the development of this book has resulted in an in-depth study of how these types of systems operate, how they should be properly applied and installed, and how they should be maintained.

The public’s desire to develop and utilize sources of alternative energy in the United States will continue to escalate throughout the next several years and beyond. Because of this demand, there will be a perpetual need for trained and qualified technicians who have the ability to understand how to install, commission, service, and repair alternative energy equipment. In order to prepare these technicians, there will be a need for comprehensive information that can be used to train and educate installers, technicians, and service people. Although there is an abundance of individual sources of information regarding alternative energy currently available, there is a need for reference literature that can compile and

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organize this information into a useable reference book that will meet the needs of today's students, technicians, and building owners.

The use of alternative energy is going to be around for a while. This is not a passing phase. Vast amounts of time and money have been spent investing in the future of alternative energy, and it is very apparent that it will be a viable source for powering America long into the future.