

# **Guide to Energy Management**

**Fourth Edition**

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# Preface to the Fourth Edition

Energy and Energy Management became household words again in the new millennium, with frequent TV and newspaper stories on electrical brownouts, blackouts and price spikes. Natural gas hit the news with price spikes over \$10 per million Btu. In California, Energy Management and improved energy efficiency finally helped tame the energy shortages that they had been experiencing. For those of us in the Energy Management profession, it was encouraging to see the positive benefits that came from a greater reliance on energy savings from new technologies, new equipment and simple operational changes.

The jobs performed by energy managers in the US and abroad have achieved a much needed level of appreciation in facilities around the world. Much of this success comes from the continuing educational improvement of energy managers as they deal with a fast growing base of new technology and new equipment. Keeping current in the field of energy management is a constant need for all successful energy managers. Hopefully, this Fourth Edition of the Guide to Energy Management will provide some very useful assistance in this constant need to acquire new knowledge.

One of the major changes to this Fourth Edition of the Guide to Energy Management is a new chapter that has been added on Distributed Generation, written by co-author William J. “Biff” Kennedy. Distributed Generation—or DG for short—has become a hot topic over the last few years as electrical generation reserves have declined and electricity prices have spiked in many areas of the country. The emphasis on power quality for facilities such as server farms or electronic commerce sites have also driven the interest in DG. This chapter presents the basic ideas and operational strategies for DG, as well as covering the common technologies for DG. These technologies are engine driven generation; gas turbine generation, including microturbines; fuel cell generation; and solar photovoltaic generation. Cogeneration and waste heat recovery are also discussed. With the emphasis on Combined Heat and Power systems from the US Department of Energy, this chapter is a timely and important addition to the Guide to Energy Management.

Thanks again go to Ms. Lynne C. Capehart for editing the changes and the new chapter for this Fourth Edition. Thanks also go to the many attendees of the Association of Energy Engineers training programs who have used the Guide to Energy Management and who have made many helpful suggestions for improving it. However, there is still room for improvement, and the authors always appreciate hearing constructive comments and suggestions from our readers.

*Barney L. Capehart*

*Wayne C. Turner*

*William J. Kennedy*

# Preface to the Third Edition

The Third Edition of the *Guide to Energy Management* will come off the press just as the new millennium appears. Will the year 2000 bring major changes to the way we purchase and use energy? Will electric deregulation, distributed generation, and new technology create a radically new approach to our daily lives as energy managers and energy efficiency professionals?

Most of these “new” topics are not really that new, and many of us have been dealing with these topics for the last several years. The field of energy management has always been a dynamic, fast-paced profession that has been driven by a combination of technological advances and energy and environmental initiatives from our federal and state governments. Rapid changes in technology and policy have created the need for quick response through both formal and organized education and individual self-education. Books such as this one, short courses and seminars, and of course the Internet are all ways to build the skills needed to succeed in our fast changing energy management jobs.

All of our new ideas, technologies and policies build on our old ones. That is why it is so important to establish a base of knowledge in energy management that we can use to quickly and easily learn and adapt to the new ideas and needs of our profession. In particular, many of these new ideas and new technologies will be needed in the federal sector to meet the goal of the executive order signed by President Clinton to reduce energy use 30% by the year 2005. In addition, President Clinton signed a new executive order on June 3, 1999 raising the federal government’s energy savings goal to 35% reduction in energy use per square foot, per year, by the year 2010 compared to a 1985 baseline.

One of the major changes to this Third Edition of the *Guide to Energy Management* is a completely new chapter on maintenance written by co-author William G. “Biff” Kennedy. This chapter ties maintenance into the energy management program, emphasizing the significant role that maintenance should play in reducing and containing energy costs. The chapter also stresses continuous improvement of the preventive maintenance function. Continuous improvement results in progressively fewer equipment failures, fewer product defects and waste, and shorter production

line changeovers.

Continuous improvement is also a good general principle in the broad area of energy management. Setting an energy use reduction goal of 2% per year, for example, is a specific quantification of a continuous improvement goal.

A major supplement to this Third Edition is a Solutions Manual to the problems at the end of the book. This Solutions Manual is separately available from Fairmont Press. Credit for the Solutions Manual goes to Mr. Klaus-Dieter E. Pawlik, who prepared the entire manual for his High Honors Project at the University of Florida, Department of Industrial and Systems Engineering, Spring 1999.

Thanks again go to Ms. Lynne C. Capehart for editing the changes to this Third Edition. And more thanks to the University of Florida students in the 1997, 1998 and 1999 EIN 4321 course in energy management who helped find errors and suggest improvements to the book. Mr. Klaus-Dieter Pawlik was especially helpful in this regard.

Energy management continues to be a dynamic and exciting area that grows each year. Even as we succeed with our current energy savings projects, new project opportunities open up because of new technology, or cheaper costs of computer/electronic-based equipment. If you are a new member of our profession, we welcome you. If you are a longer-term practitioner in energy management, we wish you continued success and energy savings accomplishments.

*Barney L. Capehart  
Wayne C. Turner  
William J. Kennedy*

# Preface to the Second Edition

The field of energy management has continued to grow and change in the four years since the first edition of Guide to Energy Management was written. New practitioners enter our profession every day, but the impetus for this growth has changed significantly in the last five years. Previously, the rapid growth and interest in utility Demand Side Management (DSM) programs fueled this impetus. However, with the 1992 Energy Policy Act, the future of utilities changed dramatically to deal with anticipated major revisions in operation from the impending deregulation of both electric generation and electric distribution and supply. As utilities pare back their DSM programs and reduce their incentives in many cases, the resulting slack has been picked up by consulting companies, Performance Contractors and even by non-regulated Energy Service Companies that the utilities themselves set up. The energy cost control and energy efficiency services that the utilities were no longer providing were still wanted by the utility's customers, so the business and interest simply shifted to another set of suppliers.

EPACT also had one other major impact on the growth of energy management, and that was with the codification of the 20% energy reduction goal by 2000 for Federal facilities and the associated requirement that every Federal facility have a trained energy manager. President Clinton's Executive Order increased that goal for Federal facilities to 30% by 2005, and instituted a level of energy reduction that was much more difficult to meet. As a result of this feature of EPACT and the Executive Order, the interest in energy management has grown significantly. Particularly since the Federal sector has little money to fund the needed energy reduction programs, the role of the Energy Service Companies, the Performance Contractors and the Shared Savings organizations has expanded tremendously in the past few years.

This growth in energy management has brought many newcomers into our profession, seeking the same tools and techniques that have served us so well for many years. The basic driving function is the availability of new, energy efficient technologies for providing our standard energy services - light, heat, air conditioning, motors, and process equipment for commercial facilities, manufacturing shops and heavy indus-



tries. Electronic computers and controls have not only provided new technology, but the price for the new technologies is most often significantly less than the cost of the older technologies. Learning how to assess the applications of these new technologies and how to estimate their energy savings and energy cost savings are still the critical skills needed.

However in today's time of shared savings, guaranteed savings and performance contracting, the accuracy of our estimates of energy and cost savings must often be much better than we provided in the past. We are learning to be much more careful with things like motor load factors, equipment running hours, full-load equivalent hours for compressors and chillers, and even actual wattage of lighting systems. Economic analysis and life cycle costing of projects are more important today than in the past. In each of these areas, the basics of analysis and estimation of power and energy consumption form the fundamental core knowledge that is needed for successful project completion. These are still the same topics that were emphasized in the first edition of Guide to Energy Management. The authors hope that the material in this Second Edition is still relevant and useful to those people who are the new entrants to the field of energy management. Good luck to you all.

Thanks again go to Ms. Lynne C. Capehart for editing the changes in this Second Edition, and to Dr. Camille DeYong for rewriting Chapter 4 on Economic Analysis and Life Cycle Costing. And thanks to the University of Florida students in the 1995 and 1996 EIN 4321 Energy Management classes who helped find most of the printing errors that remained in the First Edition.

*Barney L. Capehart  
Wayne C. Turner  
William J. Kennedy*

# Preface to the First Edition

This book is a culmination of many years of experience in energy management and is a result of our dedication to the concept of prudent energy utilization for maximum return per unit of energy consumed. We have seen organizations achieve remarkable results in energy management by applying sound engineering principles and utilizing creativity. Savings in energy and energy costs of 30% are common, and they can easily run 40-50% or more. Since energy efficiency technology continues to advance, these figures tend to remain fairly constant. Thus, the potential for future savings continues to be exciting and motivating.

The purpose of this book is to help you understand the objectives of energy management and to demonstrate and teach some of the basic techniques and tools. In the first Chapter, energy management is defined in depth. Then the proper tools for designing, initiating, and managing energy management programs are presented. In Chapter 2, we discuss energy auditing. Suggested forms, equipment and procedures are provided. Chapter 3 presents utility rate structures for various types of energy and emphasises understanding and interpreting the various structures. Engineering economy and economic decision criteria are summarized in Chapter 4. Chapters 5-10 are treatments of energy management applications in lighting, HVAC systems, boilers, steam systems, controls, and maintenance. Chapter 11 is a discussion of insulation. In Chapter 12, we show some applications of energy management to industrial processes. Finally, in Chapter 13, we discuss solar energy use, other renewable energy sources, and water management.

As this book is being completed, it is the twentieth anniversary of the great oil embargo of 1973/74. That event radically changed our view that energy would always be a commodity in plentiful supply at a very low price. Energy management—through energy conservation and energy cost control—played a very important role in the reduction of oil imports, and in the increased energy efficiency of our buildings and our industries. Renewed commitment to energy efficiency and energy cost reduction has come about because of our national concerns for economic competitiveness, environmental quality, energy security and product quality. The Energy Policy Act of 1992 has provided a tremendous impetus to energy

management in buildings and industry - both in the private sector and in government buildings and operations. The future for energy management looks very bright.

*Guide to Energy Management* is a substantially revised and expanded version of *Energy Management*, first published in 1984 by William J. "Biff" Kennedy and Wayne C. Turner. In late 1992, Barney L. Capehart was asked to help revise the book and update it to reflect some of the new approaches and technologies for energy management. He has enjoyed the opportunity to work with Biff Kennedy and Wayne Turner in expanding this pioneering book in Energy Management.

Particular thanks go to Ms. Lynne Capehart who painstakingly edited the entire book, and helped make many corrections and improvements to the manuscript. Thanks also go to Mr. Mark Spiller of Gainesville (Florida) Regional Utilities for substantially revising and updating Chapter 5 on Lighting. Mark also contributed many suggestions for improving the book.

Credit must also be given to the many students in the course EIN 4321, Energy Management, at the University of Florida who helped review, improve and update the various chapters. The students in the Spring 1993 class all helped in providing comments on both the original book, and on the draft manuscript. Two students who helped greatly were Ms. Holly Lloyd and Mr. David Enck.

Finally, we three believe strongly in America's ability to be economically competitive, to have an energy efficient economy, and to protect our environment. This book is dedicated to all of these in the hopes that each will be a little better off because of it.

W. J. K.  
W. C. T.  
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