High-Performance Buildings Simplified

Designing, Constructing, and Operating Sustainable Commercial Buildings

Second Edition

Tom Lawrence • Julia Keen



ASHRAE®

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This publication was prepared under the auspices of
ASHRAE Technical Committee 2.8, Building Environmental Impacts and Sustainability.

ABOUT THE AUTHORS

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This book is accompanied by supplemental materials, which can be found online. These additional study and reference resources are available in PDF format or as links to online sources. If the files or links at this URL are not accessible, please contact the publisher.

Preface and Acknowledgments

It has been interesting to watch the growth and evolution of the concept of high-performance buildings (originally referred to as *green buildings*) over the past roughly 30 years. Though it started as a niche market with a few committed early adopters, the concept has grown to become part of industry mainstream thinking. Even the term *green building* has evolved; this book uses the term *high-performance building* instead. A high-performance building focuses on all the key topical areas that one would ascribe to a green building but strives to do so in a cost-competitive manner and to incorporate principles that have become equally important, such as improved indoor environmental quality (air quality, thermal comfort, etc.) and resilience in design. The topics related to high-performance buildings include many more than just energy. They also include carbon footprint, water efficiency, indoor environmental quality, materials and methods used in building construction, and the operation and maintenance of the building; all of these factors help to maintain high-performance characteristics beyond initial design and construction.

One purpose for the second edition of this book is to update the content with information and data related to this rapidly evolving field; for example, the concept of building decarbonization was not really a topic of discussion when the first edition was written but is now becoming a hot topic. Thus, although the core parts of this book come from an engineering perspective, it is designed to help instruct and guide students and early-career professionals from all disciplines in the principles of high-performance building design, construction, and operation. While the focus in this book is on commercial buildings, many concepts discussed can be generalized to the residential sector also.

The structure of and exercises in this book are based on a Sustainable Building Design course taught each year at the University of Georgia since the fall 2007 semester. Although that course originated with a focus on serving engineering undergraduate students, it is now offered as an upper-division elective to students of all majors. This was purposely done to allow engineering students to gain insight into topics outside of their own personal technical discipline as well as help students from disciplines outside of engineering learn about the core technical aspects of a high-performance building. It is important that more than just the engineers responsible for the design of a building be educated on this topic. Future building owners, government officials, financiers, building occupants, and others play important roles in driving and supporting decisions targeting high-performance building design.

This book is structured to serve as a guide for a flipped or at least partially flipped course. By this, I mean that it is designed to provide concepts and background on topics that could be studied outside of the classroom (or studied on their own by an early-career professional), reserving class time for instructor-lead discussion. Additional outside-of-class activities, suggested design projects, and learning exercises are other key components of this text. We have generally tried to keep the discussions and exercises at an introductory level, but we also include some that require more in-depth background knowledge.

Some content in this text builds on material from *ASHRAE GreenGuide*, the last three editions for which I have served as a senior editor. In developing the concept for *High-Performance Buildings Simplified*, we

(the contributors to *ASHRAE GreenGuide* and the members of ASHRAE Technical Committee 2.8) realized that there existed the need for not just a publication focused toward experienced professionals (the *GreenGuide*) but also one focused toward students and early-career professionals (*High-Performance Buildings Simplified*). The *GreenGuide* is a publication whose many editions have been compiled by numerous ASHRAE volunteers for more than 20 years now, and the contributors are far too many to list (literally dozens of people) and there are also many who provided editorial suggestions. But of those volunteer editors, we would like to recognize the contributions of Janice Means and Abdel Darwich in helping to lead the development of the most recent editions of The *GreenGuide*. That material helped serve as the seed material for portions of this book.

Instructors, students, and early-career professionals using this book are encouraged to provide feedback and suggestions about this book to ASHRAE and to my email address given below. In particular, suggestions for additional exercises or refinements to the ones presented in this book are very much welcome.

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Book Topics and Organization

The following diagram outlines the general topical flow of this book. Section 1 introduces the basic terms, defines what is meant by a high-performance building, and covers the various methods for rating or certifying that a building is high performance. Section 2 outlines the various methods used to design and then deliver a building as well as the quality assurance process (commissioning); it also includes chapters that focus on specific design topics. Section 3 covers materials selection and the construction, startup, and operation of a building. Section 4 introduces technologies and topics that are trending in the industry.

