

HANDBOOK OF

# Green Building Design and Construction

*LEED®*, *BREEAM®*, and *GREEN GLOBES®*

**SAM KUBBA**  
Ph.D., LEED AP



# Handbook of Green Building Design, and Construction

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Sam Kubba, Ph.D., LEED AP



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## Dedication

**To my friends and colleagues everywhere,  
without whom life would be meaningless and hollow and  
To my wife and four children whose love and affection  
continues to inspire me through the years**

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## Foreword

When I was an Executive Editor at GreenBiz.com, I spent a lot of time trying to reduce the number of words used to make a point. I dream of the day when editors can edit out the word “green” from the title of Dr. Kubba’s thorough Handbook. At that point, there will be no such thing as green buildings, only buildings that operate comfortably and economically in harmony with the natural flows of the Earth—buildings that not only nourish and restore the occupants but also the planet itself.

Confronted by overwhelming scientific evidence that our current linear make-use-toss-repeat way of life is fast rendering the planet unfit for human habitation, we urgently need to take measures to come back into balance with the beautiful and finely tuned web that supports all species’—including our—life. Green buildings are beginning to take us in this direction, and it is vital that the growing amount of knowledge to make buildings better be disseminated widely.

Recognizing that a chain can break at its weakest link, Dr. Kubba’s *Handbook of Green Building Design, and Construction* covers all of the key elements of successfully executing a sustainable building from concept to operation, from permitting to (avoiding) litigation and liability. Drawing extensively from research conducted for his other two books on LEED® certification and managing green projects this book is chock-full of practical project advice, as well as numerous proof sources of both the benefits of green buildings and resources for debunking the most common myths that stand in the way of wider dissemination of building green.

When I was leading the development of LEED and was showing the draft system to design professionals, a few of them said, “I don’t get it, this is just good design.” Actually, they got it exactly: a green building is a good building. If a building isn’t green, it’s not a good building. Period. End of story. Dr. Kubba’s book and his work to promote good building around the world make an important contribution to the betterment of humankind.

**Robert (Rob) Watson, LEED AP (BD&C)**  
CEO, EcoTech International

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## Acknowledgments

It would not have been possible for me to produce a book of this size and scope without the active and passive support of many friends and colleagues who have contributed greatly to my thinking and insights during the writing of it and who were in many ways instrumental in the crystallization and formulation of my thoughts on the subjects and issues discussed within. To them I am heavily indebted, as I am to the innumerable people and organizations that have contributed ideas, comments, and illustrations, that have helped make this book a reality.

I must also unequivocally mention that without the unfailing fervor, encouragement, and wisdom of Mr. Kenneth McCombs, Senior Acquisitions Editor, Elsevier Science and Technology, this book would still be on the drawing board. It is always a great pleasure working with the company. I would like to thank Mr. Michael Joyce, Editorial Project Manager, who helped smooth many of the “bumps” along the way. Likewise, I must acknowledge the wonderful work of Ms. Marilyn E. Rash, Project Manager, who coordinated the day-to-day details of the *Handbook* and who saw it through production. I also wish to thank her for her unwavering commitment and support. I also wish to thank Ms. Samantha Graham, a highly valued and dedicated member of the Elsevier’s support team, for proofreading the first pages. I would especially like to salute and express my deepest appreciation to all of the Elsevier team for seeing the book through production, and to SPi in India for formatting the pages, and Eric DeCicco for the excellent cover design.

I am particularly indebted to the U.S. Green Building Council (USGBC) and its staff for their assistance, continuous updates, and support on the new LEED® 2009 Version 3 Rating System, and to Ms. Anica Landreneau of HOK for reviewing Chapter 5. I also wish to express my appreciation to Mr. Rob Watson, CEO of EcoTech International for reviewing the Introduction and Chapters 1 and 2, in addition to his informative comments. Last but not least, I wish to record my gratitude to all those who came to my rescue during the final stretch of this work—the many nameless colleagues, architects, engineers, and contractors who kept me motivated with their ardent enthusiasm, support, and technical expertise. To these wonderful professionals, I can only say, “Thank you.” I relied on them in so many ways, and while no words can reflect the depth of my gratitude to all of them for their assistance and advice, in the final analysis, I alone must bear responsibility for any mistakes, omissions, or errors that may have found their way into this book.

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# The Green Movement—Myths, History, and Overview

One of the hottest topics over the last decade in the field of property development is the concept of sustainable development and green building. Yet, it is not easy to give a precise definition of what makes a building green. One definition offered by the Office of the Federal Environmental Executive (OFEE) for green building is:

*[T]he practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and (2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle.*

The EPA defines green building as, “the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building’s life cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction.”

So essentially when correctly applied, green building is meant to improve design and construction practices so that the buildings we build last longer, cost less to operate, and facilitate increased productivity and better working environments for workers or residents. But even more than that, it is also about protecting our natural resources and improving the built environment so that the planet’s ecosystems, people, enterprises, and communities can live a healthier and more prosperous life.

The general perception of the green movement has been considerably transformed since its early formative days and is today sweeping across the United States and much of the world. Furthermore, sustainable development principles are taking on an increasingly important role in real estate applications, particularly by forward-looking developers. In fact, many contractors are now seeking green certification and, with this in mind, the Associated Builders and Contractors, Inc. (ABC) has recently initiated a program that would certify “Green Contractors.” Nevertheless, some developers refuse to jump on the environment-friendly, or “green” building, bandwagon mainly due to the misplaced notion that green buildings cost more or that they are impractical to construct.

## GREEN BUILDING: MYTHS AND REALITIES

There are many myths about sustainability floating in the ether. One example is the myth that sustainability costs more, which ignores recent research as well as the reality that for any society to thrive and prosper, it must seek to create a healthy balance between its environmental, social, and economic dimensions. Sustainability is not just about building green but about building a healthy community and sustaining a quality way of life. As reminded often by President Obama and his cabinet, as a community we cannot afford to continue delaying the pursuit of new sources of energy such as wind, solar, and geothermal. With the state of the economy being what it is, these efforts would help create new jobs, attract new businesses, reduce our energy costs, and create a healthy environment. Although green building has made tremendous strides in the past few years, there remain many who are still unconvinced of its benefits due to the numerous myths and misconceptions floating around the mainstream construction and real estate industries, as described next.

### **Myth 1: Green/sustainable buildings cost much more than conventional buildings**

*Reality check:* This is a very common misconception that continues to linger on even though it has been debunked many times over. Although on a price per square foot basis, building green may incur marginally greater upfront costs, in the long run a green home is more affordable and cost effective because the operational costs are lower when compared with conventional buildings. It is surprising therefore that some developers still believe that building with green materials or renovating to green specifications is cost-prohibitive. In addition to this, there are various strategies and approaches that can be employed to achieve inexpensive green building. These include reducing waste, optimal value engineering, right-sizing the structure to using solar panels, low-e windows, and energy-saving appliances, and more—all of which can help qualify the project for federal tax credits. Moreover, when green thinking becomes an integral part of the initial building plans, it is easier to design and incorporate green elements into the project.

### **Myth 2: It's just another fad and therefore not particularly important**

*Reality check:* Over the last decade, we have witnessed an increasing interest in sustainability and a continuous growth in green building and green building certification—so much so that it has now become more than an integral part of the mainstream in the construction industry, and it is becoming the preferred building method. Furthermore, creating a healthy environment where green building does not exist cannot be considered a fad.

### **Myth 3: Green buildings are often “unattractive” or “ugly” and lack the aesthetic quality of conventional buildings**

*Reality check:* A green/sustainable building doesn't have to look any different from a conventional building. In fact many of today's green buildings are virtually indistinguishable from traditional buildings. Moreover, green renovations of existing buildings should respect its character and if well designed, most likely won't be noticeable from either the interior or exterior. Thus, wood certified by the Forest Stewardship Council (FSC) looks essentially the same as other types of wood, and when using a vegetated roof, for example, it would not typically be visible from ground level. Moreover, one does not have to mount continuous rows of unattractive solar panels to be green or be obligated to go with solar power, although there are numerous ways to creatively integrate photovoltaic (PV) panels into a project that are both attractive and effective. Likewise, eco-friendly shingles are actually more attractive than the common asphalt versions and some renovations are actually invisible (e.g., extra insulation or a new energy-efficient HVAC system).

### **Myth 4: Green building is essentially about eco-friendly material selection**

*Reality check:* Not at all. Green building is mainly concerned with how you design and orient your building, site selection, water conservation, energy performance, window location, and so on. However, making smart decisions regarding eco-friendly building materials (e.g., those possessing a high recycled content, low embodied energy, minimal VOCs) is an important aspect of green building, but they are only a small part of the overall equation. Alex Wilson, president of BuildingGreen Inc. and executive editor of *Environmental Building News*, says: “People are beginning to gain a greater understanding that green building is a systems approach to the entire construction process.”

### **Myth 5: Green buildings do not fetch higher rental rates or capital compared with traditional buildings**

*Reality check:* Recent surveys consistently show that there is a growing market demand for green buildings because they achieve much higher rentals, thus capital, as a result of reduced operation costs and higher productivity of employees. For example, a recent Building Owners and Managers Association (BOMA) survey in Seattle concluded that 61% of real estate leaders opine that green buildings enhance their corporate image and more than two-thirds of those surveyed believe that over the next five years tenants will make the “greenness” of property a significant factor in choosing space. Tenants and developers therefore do care about green and healthier environments and are willing to pay for it.

This trend is already particularly evident in high-end residential projects and flagship corporate office projects and is very likely to become widespread.

### **Myth 6: Green buildings do not provide the comfort levels that many of today's tenants demand**

*Reality check:* On the contrary, green buildings are typically more comfortable and healthier than conventional buildings. In fact, one of the chief characteristics of sustainable design is to support the well-being of building occupants by reducing indoor air pollution from exposure to contaminants (e.g., asbestos, radon, and lead), therefore avoiding complaints such as sick building syndrome (SBS) and building-related illness (BRI). This can normally be achieved by selecting materials with low off-gassing potential; proper ventilation strategies; adequate access to daylight and views; and optimum comfort through control of lighting, humidity and temperature levels. This is not the case with traditional building environs.

### **Myth 7: Green building products are often difficult to find**

*Reality check:* This may have been true a decade or so ago when it may sometimes have been difficult to find eco-friendly or energy-saving materials at a reasonable price; today, green building materials are more popular than ever and have become much more accessible. Where green building products are not readily accessible, it may be because they are not manufactured nationwide or they may be difficult to find in certain parts of the country; in such cases, it is usually possible to find satisfactory alternatives. Indeed, the number of green products and systems that are now readily available on the market has dramatically increased during recent years and is growing continually. So much so that green building products are now in the thousands and have become part of the mainstream. Much information—including performance data and contact details—can also be obtained from the various green product directories on the market such as the two comprehensive directories published by Building-Green Inc. (*GreenSpec*<sup>®</sup> *Directory* and *Green Building Products*).

### **Myth 8: Green building uses traditional tools and techniques and not cutting-edge technology**

*Reality check:* The most successful green building design projects generally use a multidisciplinary and integrated design approach, where a number of consultants and the owner's representative participate as a team and the architect typically takes on the role of team leader rather than sole decision maker. In most cases, locally available materials and techniques are used in addition to the latest technology. This is reinforced by the U.S. Environmental Protection Agency's website, which clearly states that "green building research is being done by

national laboratories, private companies, universities, and industry.” According to a recent U.S. Green Building Council (USGBC®) report, in excess of 70% of the green building research is focused on energy and atmosphere research.

### **Myth 9: Green building products don’t work as well as traditional ones**

*Reality check:* Examples of typical products that frequently get a bad rap include double-flush and low-flow toilets. It may be true that when first introduced, low-flow toilets did not function that well, and some people are still of the opinion that 1.6 gallon-per-flush toilets don’t work as well as traditional toilets, even though these fixtures have been mandated for all new construction for more than a decade. Moreover, recent surveys show that when customers are asked to comment on their satisfaction with their new 1.6-gal., high-efficiency toilet fixtures, the majority say they double-flush the same number of times or fewer with their new efficient fixture than with their old water waster. The “don’t work as well” myth was reinforced with the introduction of compact fluorescent light bulbs (CFLs), which gave off harsh color, didn’t last as long as claimed, and took too long to light up. Another green building product myth often cited relates to fiberglass insulation in that inhaling fiberglass fibers can lead to cancer, which is obviously false.

It is therefore important to research unfamiliar products and seek accurate information to back up any efficiency claims prior to formulating a final opinion regarding its suitability or lack thereof. However, generally speaking, most modern new green products work as well, if not better than traditional ones, and green products have been vastly improved in recent years. It should be noted that green materials like traditional building materials also have to meet strict quality-control standards, and as the green market grows, new upgrades will undoubtedly take place to improve quality and reliability.

### **Myth 10: Building green is too difficult and complicated**

*Reality check:* Nothing is further from the truth; in fact many builders consider green building to be very easy and compares favorably with conventional building. Building green is a business that can be simple, uses common sense, and does not require a rocket scientist to implement. Basically, build it smaller, use quality materials chosen for sustainability and efficiency, not for the fad of the month.

### **Myth 11: It is not possible to build a high-rise green building**

*Reality check:* Green concepts do not generally inhibit or restrict building design or space usability. Furthermore, all modern techniques that apply to conventional building can be employed when building *green*. A good example of this is the Condé Nast Building (officially 4 Times Square) located in Midtown

Manhattan. The building boasts 48 stories and rises to 809 feet (247 m). It is environmentally friendly with gas-fired *absorption chillers*, and a high-performing insulating and shading curtain wall, which keeps the building's energy costs down by not requiring heating or cooling for most of the year. In addition, the building uses solar and fuel-cell technology, making it the first project of its size to incorporate these features in construction.

### **Myth 12: It is difficult or not possible to convert existing conventional buildings into energy efficient buildings**

*Reality check:* It is not really difficult to convert existing buildings into green/sustainable buildings. Actually, there are numerous scientific ratings and checklists that builders can use to redesign and realign traditional buildings to meet modern green standards. Likewise, many rating systems, such as Leadership in Energy and Environmental Design (LEED®) for existing buildings, Canada's Go Green Plus, and the Japanese CASBEE certification system, all encourage such conversions. To this end, President Obama after becoming president committed his administration to retrofitting 75% of all existing federal buildings. It is important therefore to increase public awareness of how baseless these myths are and to do all that is possible to eliminate them.

### **Myth 13: Building green requires signing up for a green program or third-party certification**

*Reality check:* This is definitely not a normal requirement for building green, although certification programs, such as Green Globes® and the U.S. Green Building Council's LEED, are excellent vehicles for increasing exposure and furthering the green movement and, it must be said, that without third-party certification, much of the value of "green" is lost. In addition, keep in mind that the LEED Rating System is, in most cases, a totally voluntary program: You pay your fees, follow the LEED guidelines, and ultimately receive a plaque or certificate stating your building has achieved a Silver, Gold, or whichever status. More important, however, remember that there are many financial and other government incentives to attain certification. Moreover, building owners and developers can reap the financial benefits of the "greenness" of their building projects by taking advantage of the various tax credits and private and public non-tax financial incentives available, as well as tenant monetization of reduced operations and maintenance costs and carbon and renewable energy tradable credits.

### **Myth 14: Going green is an all-or-nothing proposition**

*Reality check:* Many developers and construction professionals have the misconception that going green with existing buildings involves large-scale remodeling. In fact, the degree and scale of incorporating green into a building is



wholly up to the owner, depending on the individual lifestyle and budget. Many builders and designers often use green concepts and green products intuitively without being fully aware of them. This is rapidly changing with increased awareness and demand for green products, and many manufacturers and the construction industry find themselves moving in this direction.

## GREEN BUILDING AND THE GREEN MOVEMENT: ITS HISTORY

For an in-depth and more comprehensive understanding of the modern green movement, it helps to try and trace its origins back to the beginning. However, it is almost impossible to determine precisely when a movement may have started. Long before the arrival of the industrial revolution and electrically powered heating and cooling systems, ancient and primitive populations were compelled to improvise using basic tools and natural materials to construct buildings that protected them from the harsh elements and extremes in temperature. Particularly, as the ancients had few other options at their disposal, these builders incorporated passive design that took advantage of the resources provided by nature, namely the sun and climate to heat, cool, and light their buildings. The Babylonians and Egyptians, for example, used adobe as their prime building material and built *badgeer* (wind shafts) into their palaces and houses. They took advantage of courtyards and narrow alleyways for shade. These are simple examples of how the ancients overcame the many challenges of climate that faced them.

More recently however, we find scholars like Mark Wilson who believe that the concept of green building first appeared in America more than a century ago. According to Wilson:

*The revolutionary design philosophy known as First Bay Tradition had its roots in the San Francisco Bay Area in the 1890s. Indeed, the leading practitioners of this environmentally sensitive organic movement, Bernard Maybeck and Julia Morgan, developed a design philosophy that incorporated most of the concepts that are embraced by today's green movement in architecture.*

Some historians associate its beginning with Rachel Carson's (1907–1964) book, *Silent Spring*, and the legislative fervor of the 1970s, or with Henry David Thoreau who in his book, *Marine Woods*, advocates for the respecting of nature and also for an awakening to the need for conservation and federal preservation of virgin forests. Many believe that the green movement had its roots in the energy crises of the 1970s and the creative approaches to saving energy that emanated from it, such as smaller building envelopes and the use of active and passive solar design.

When the 1973 OPEC oil crisis erupted, it brought the cost of energy into sharp focus and reminded us that our future prosperity and security was in the hands of a very small number of petroleum-producing countries. This catalyzing event effectively highlighted the need for diversified sources of energy and