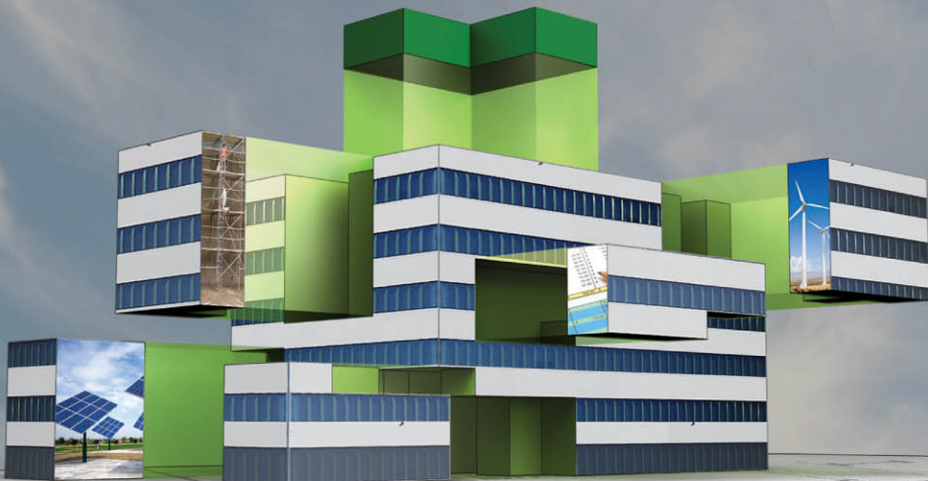


A GreenSource BOOK

LEED-New Construction Project Management



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Foreword by Jerry Yudelson

INTRODUCTION

From *Green* to *LEED*

Green building design or, at least, the principles of building green have been around for thousands of years. Examples in history and vernacular architecture all over the globe show that buildings were designed and built in direct response to natural climatic conditions. These structures were *green* even before the term was coined. Right from caves to tents to igloos, people adapted their shelter structures to the natural surroundings. Pueblo Indians, for instance, used a southern exposure plus overhanging cliffs to warm their adobes in winter, while sunlight struck less directly during the hot summer.¹ The ancient Romans similarly employed southern facing houses to trap heat inside during the cold winter months, using clear materials like mica or glass, which acted as solar heat traps.²

In fact, good building design should be inherently *green*—oriented to maximize the benefits of sunlight and wind, with an envelope that is designed in response to the local climate and with building systems and components that are energy, water, and resource efficient. These should be fundamental to the way buildings are designed. However, with the advent of heating and air conditioning systems in the twentieth century, there was a dramatic shift in the way buildings were designed. It became easy to alter the internal environment rather than designing in response to external climate conditions. As green building pioneer William McDonough puts it in the Foreword to *Big and Green*, “Most conventional practitioners of modern design and construction find it easier to make buildings as if nature and place did not exist. In Rangoon or Racine, their work is the same.”³ Modern buildings became isolated from the immediate environment and started consuming energy created by burning fossil fuels, like coal and oil. Buildings became one of the major sources of consumption of energy in the world, in the United States in particular.

During the 1970s, because of the energy crisis, there was a push to build energy-efficient and green buildings. Incentives were provided to use solar technologies, and there was a growing concern about environmental issues arising from depletion of resources. But the movement was considered more of a trend and it soon died out in the 1980s with the boom in the economy, falling oil prices, and changes in government regulation. Despite these early efforts, *green* never really became a part of modern

architectural vocabulary. With no serious efforts made toward energy efficiency, the last thirty years have seen a tremendous increase in consumption of energy and resources by the building sector. This has escalated to the point that, now, buildings account for about 48% of the total energy consumption in the United States.⁴

Today, the large energy footprint of buildings and their role in contributing to climate change are finally being realized, and the building community is slowly reinventing itself to design and operate buildings in more energy-efficient ways. The next four decades present to us an amazing opportunity to redefine the path of building design and reverse the negative impact of buildings on the environment. There have been many reasons attributed to this resurgence of green building, such as:

- 1** Increased awareness of the role of buildings in contributing to global climate change
- 2** Emergence of green building rating systems
- 3** Realization of cost-effectiveness of building green
- 4** Several local and federal incentives
- 5** Availability of new resources, materials, and technologies

One of the most significant factors that has transformed the building industry is the emergence of several green building rating systems, such as Leadership in Energy and Environmental Design (LEED®), Building Research Establishment Environmental Assessment Method (BREEAM™), GreenGlobes™, Green Star™, etc.⁵ Refer to Table 1.1 for examples of some green-building rating systems across the globe. Of these, the LEED rating system developed by the U.S. Green Building Council® (USGBC) has become one of the most recognized and internationally accepted benchmarks. The rating system provides a framework to design, build, and operate green buildings and presents metrics to

TABLE 1.1 EXAMPLES OF GREEN BUILDING RATING SYSTEMS	
COUNTRY	RATING SYSTEM
United States	Leadership in Energy and Environmental Design (LEED)
Canada	LEED Canada
India	LEED India and Indian Green Building Council (IGBC) Rating System
United Kingdom	Building Research Establishment’s Environmental Assessment Method (BREEAM)
Australia	Green Star
New Zealand	Green Star NZ
South Africa	Green Star SA
Germany	German Sustainable Building Certification
Canada	Green Globes
Japan	Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)
Malaysia	Green Building Index
Singapore	GreenMarks

measure their performance. Since its inception in 1998, the LEED rating system has played a major role in catalyzing the green building movement and bringing it to the mainstream. The proof lies in the thousands of buildings that are registered to be certified, the growing number of members in the USGBC organization, the advancement in the products and technologies available to build green, the number of governments mandating LEED certification, the increasing number of LEED projects outside the United States, and the list goes on.⁶ LEED has permeated the industry to such an extent that financiers for new development projects now have LEED as a prerequisite for funding a project. The environmental, economic, and social benefits of green buildings along with the brand value associated with LEED will only ensure that green buildings continue to grow. Critics argue that LEED takes a mechanical approach to green building design and that certification is not really necessary to design green buildings. However, it must be noted that LEED provides a broad framework that serves as a starting point for green building design, and the certification process provides a measure of success and ensures accountability.

In summary, the building community needs to revive some of the traditional principles of good design, which were lost or disregarded, and combine them with the many modern-day solutions, so that buildings can truly make an impact in reducing energy use, conserving resources, and creating healthy environments. Tools such as the LEED rating system augment the process of green building design. Today, LEED buildings have become synonymous with green buildings. Figure 1.1 illustrates the evolution of green buildings.

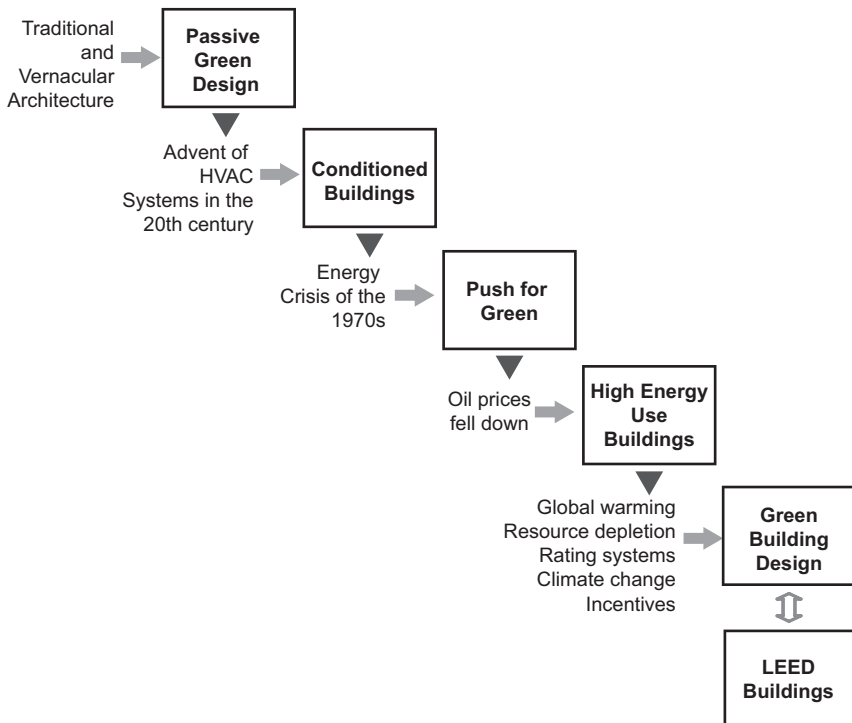


Figure 1.1 Evolution of green buildings.

The Fundamentals of the LEED Rating System

Since the first LEED pilot project program was released in 1998, the rating system has undergone many revisions—version 1.0, 2.0, 2.1, 2.2—to version 3 or LEED 2009, which is the current rating system. The system has evolved over the last decade and grown to include rating systems to cater to various building types, sectors, and project scopes. Examples include LEED for Existing Buildings: Operations & Maintenance (LEED-EBOM), LEED for Core & Shell (LEED-CS), LEED for New Construction (LEED-NC), LEED for Schools, LEED for Homes, and LEED for Commercial Interiors. There are several pilot programs that are under way and expected to be released to the public in the next year or so. These include LEED for Neighborhood Development, LEED for Retail, LEED for Healthcare, and LEED Portfolio program. The first rating system was the LEED-NC system, which was written with a fairly broad scope of requirements that allowed a number of building types to get certified. Until 2008, USGBC administered the certification process for projects. Now the registration and certification processes are handled by the Green Building Certification Institute (GBCI), which also administers credentialing of LEED Accredited Professionals.

The LEED rating systems are voluntary, consensus-based, and market-driven. Based on existing and proven technology, they evaluate environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a green building in design, construction, and operation.⁷

In 2009, the latest version of LEED—version 3 (LEED v3)—was released by the USGBC. The first key difference between this version and earlier versions is that the maximum number of points available and the number of points per credit have changed. Earlier versions of LEED had varying number of points across the various rating systems, and all credits were weighed equally at 1 point. LEED v3 has standardized the number of total points available across all rating systems to 100 base points. In addition, the allocation of points among credits is based on potential environmental impacts and human benefits of each credit with respect to a set of impact categories. This means that the credits are weighted according to the relative importance of the building-related impacts they address, thereby making some credits worth more than 1 point. Another significant difference between LEED v3 and the earlier versions is that the intent and requirements governing the LEED-NC, LEED for Schools, and LEED for Core & Shell rating systems have been combined into a single LEED reference book titled, *LEED Reference Guide for Green Building Design and Construction*. The guide provides various credit criteria, implementation strategies, and documentation requirements for each of these rating systems.

The focus of this book is on the LEED-NC rating system. The project management processes, implementation tools, and documentation samples included in this book are written with the LEED-NC rating system in mind. Projects using other rating systems may also leverage information as applicable to their projects. Figure 1.2 presents

a timeline of the different versions and types of LEED rating systems based on their year of release.

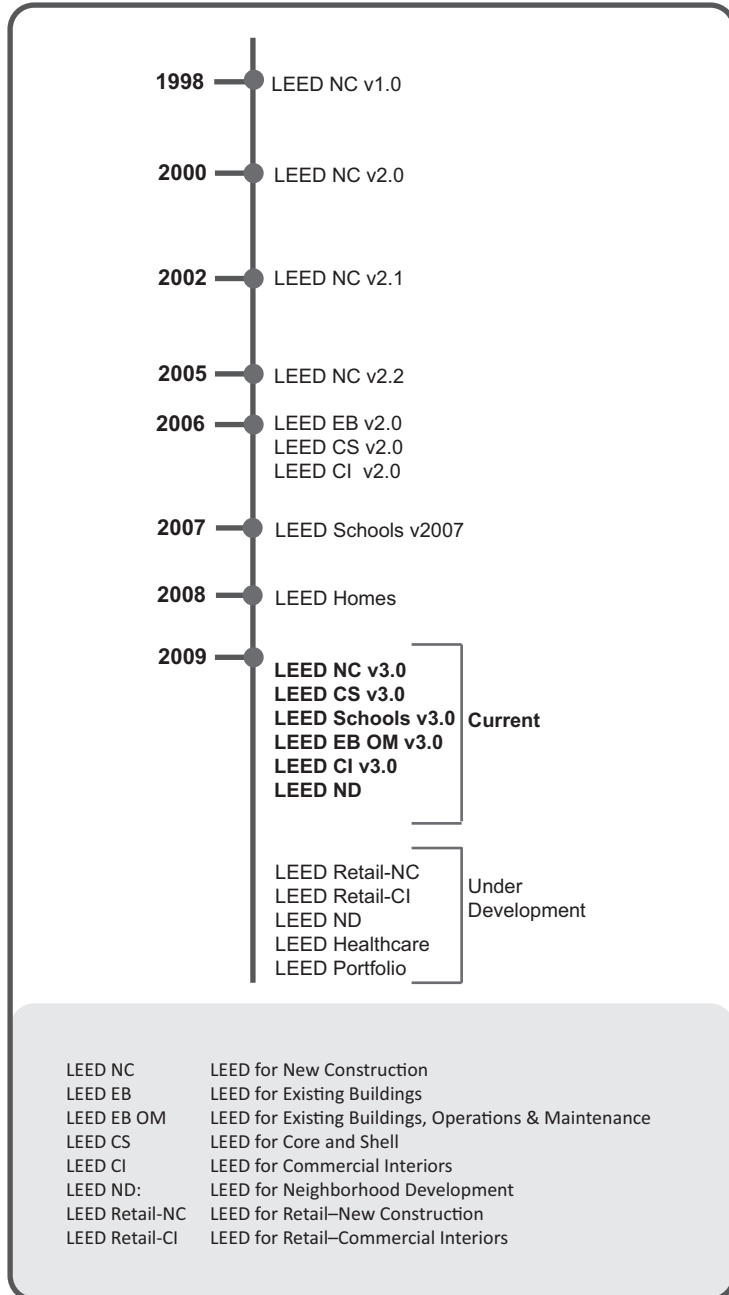


Figure 1.2 History of the LEED rating system.

LEED-NC CREDIT CATEGORIES

The LEED-NC rating system provides a framework for design, construction, and operation of buildings from a whole building perspective and recognizes performance in seven key areas. Points are awarded for achievement of credit requirements in each of these areas. In addition, there are certain prerequisites under each category that the project must meet in order to qualify for consideration of other credits. The seven categories are:

- 1** Sustainable Sites
- 2** Water Efficiency
- 3** Energy and Atmosphere
- 4** Materials and Resources
- 5** Indoor Environmental Quality
- 6** Innovation in Design
- 7** Regional Priority

Sustainable Sites (SS)

This category of credits provides guidance on how to select, design, and manage project sites. It specifically encourages building on previously developed land, designing regionally appropriate landscape, and utilizing best management practices for storm-water quality and quantity control. The category also rewards smart transportation choices and reduction in erosion, light pollution, heat island effect, and construction activity pollution. The credits, in essence, try to mitigate some of the negative effects buildings have on the local and regional environment. Table 1.2 lists the credits that fall under this category of the LEED-NC system. A total of up to 26 points may be achieved in this category. The credits in this category are typically referenced in this book as “SS Cx” or “SS Px” where “SS” represents “Sustainable Sites,” “C” indicates “Credit,” “P” indicates “Prerequisite,” and “x” represents the credit or prerequisite number. For instance, Credit 1 in the “Sustainable Sites” category would be referred to as SS C1.

Water Efficiency (WE)

The increasing use of potable water by buildings has caused a severe drop in the water level in underground aquifers and led to a strain on the country’s water resources.⁸ The credits and prerequisites in this category outline water reduction targets and encourage the use of various strategies, such as using high efficiency fixtures, reusing rain-water, etc. to reduce the amount of potable water used in buildings, thereby minimizing the strain on municipal water supply sources and systems. It also encourages the use of efficient irrigation and landscape design strategies to reduce the amount of water used for irrigation purposes. Table 1.3 lists the LEED-NC credits that fall under this category. These credits are typically referenced in this book as “WE Cx” or “WE Px” where “WE” represents “Water Efficiency,” “C” indicates “Credit,” “P” indicates “Prerequisite,” and “x” represents the credit or prerequisite number. For instance, Credit 1 in the “Water Efficiency” category would be represented as WE C1. A maximum of 10 points may be achieved in this category.

TABLE 1.2 LEED-NC SUSTAINABLE SITES CREDITS

CREDIT	TITLE	POINTS
Prerequisite 1	Construction Activity Pollution Prevention	
Credit 1	Site Selection	1
Credit 2	Development Density and Community Connectivity	5
Credit 3	Brownfield Redevelopment	1
Credit 4.1	Alternative Transportation—Public Transportation Access	6
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
Credit 4.4	Alternative Transportation—Parking Capacity	2
Credit 5.1	Site Development—Protect or Restore Habitat	1
Credit 5.2	Site Development—Maximize Open Space	1
Credit 6.1	Stormwater Design—Quantity Control	1
Credit 6.2	Stormwater Design—Quality Control	1
Credit 7.1	Heat Island Effect—Non-roof	1
Credit 7.2	Heat Island Effect—Roof	1
Credit 8	Light Pollution Reduction	1

Energy and Atmosphere (EA)

Buildings are known to use 39% of the total energy and 74% of the total electricity produced annually in the United States.⁹ This category of credits and prerequisites sets standards for minimum energy efficiency of buildings and encourages the use of various strategies to reduce their overall energy consumption. It also rewards monitoring the energy used and supplementing it with on-site renewable energy systems. Table 1.4 identifies the credits in this category. Up to 35 points can be achieved by implementing various credit requirements in this category. The credits are typically referenced in this book as “EA Cx” or “EA Px” where “EA” represents “Energy and

TABLE 1.3 LEED-NC WATER EFFICIENCY CREDITS

CREDIT	TITLE	POINTS
Prerequisite 1	Water Use Reduction—20% Reduction	
Credit 1	Water Efficient Landscaping	2 to 4
Credit 2	Innovative Wastewater Technologies	2
Credit 3	Water Use Reduction	2 to 4

TABLE 1.4 LEED-NC ENERGY AND ATMOSPHERE CREDITS

CREDIT	TITLE	POINTS
Prerequisite 1	Fundamental Commissioning of Building Energy Systems	
Prerequisite 2	Minimum Energy Performance	
Prerequisite 3	Fundamental Refrigerant Management	
Credit 1	Optimize Energy Performance	1 to 19
Credit 2	On-Site Renewable Energy	1 to 7
Credit 3	Enhanced Commissioning	2
Credit 4	Enhanced Refrigerant Management	2
Credit 5	Measurement and Verification	3
Credit 6	Green Power	2

Atmosphere,” “C” indicates “Credit,” “P” indicates “Prerequisite” and “x” represents the credit or prerequisite number. For instance, Credit 1 in the “Energy and Atmosphere” category is referred to as EA C1.

Materials and Resources (MR)

This category of credits focuses on reducing the amount of waste that buildings generate during both their construction and operation cycles. It encourages the selection of sustainable materials that incorporate recycled content, are made from rapidly renewable materials, and are sourced regionally. The category also rewards minimization of landfill and incinerator disposal for materials that leave the building. Up to 14 points can be achieved in this category (Table 1.5). The credits in this category are typically referenced in this book as “MR Cx” or “MR Px” where “MR” represents “Materials and Resources,” “C” indicates “Credit,” “P” indicates “Prerequisite,” and “x” represents the credit or prerequisite number. For instance, Credit 1 in the “Materials and Resources” category is represented as MR C1.

Indoor Environmental Quality (EQ)

This category of credits is written with the intent of improving the overall indoor environmental quality of buildings. On an average, Americans spend about 90% of their day indoors, making it necessary to design indoor environments that are healthy and comfortable.¹⁰ The EQ credits reward projects that provide improved ventilation, monitor outdoor air, are designed with occupant thermal comfort in mind, and provide controllability of lighting and thermal comfort systems by individual occupants. It also encourages the use of daylighting and improving access to outdoor views for occupants. A total of 15 points can be achieved in this category (Table 1.6). The

TABLE 1.5 LEED-NC MATERIALS AND RESOURCES CREDITS

CREDIT	TITLE	POINTS
Prerequisite 1	Storage and Collection of Recyclables	
Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
Credit 2	Construction Waste Management	1 to 2
Credit 3	Materials Reuse	1 to 2
Credit 4	Recycled Content	1 to 2
Credit 5	Regional Materials	1 to 2
Credit 6	Rapidly Renewable Materials	1
Credit 7	Certified Wood	1

credits in this category are typically referenced in this book as “EQ Cx” or “EQ Px” where “EQ” represents “Environmental Quality,” “C” indicates “Credit,” “P” indicates “Prerequisite,” and “x” represents the credit or prerequisite number. For instance, Credit 1 in the “Indoor Environmental Quality” category is referred to as EQ C1.

Innovation in Design (ID)

The Innovation in Design credits offer projects a chance to gain extra points in addition to the credit points offered in the previous categories. Up to 6 points can be achieved under this category. There are two ways by which these credits can be achieved: one is by demonstrating use of innovative strategies to improve the building’s performance beyond what is required by the LEED credit (these are referred to as *exemplary performance* points) and the second way is to pursue innovative ideas that are not specifically addressed by any credit in the rating system. There is also one point available for having a LEED Accredited Professional (LEED AP) on the project team. Table 1.7 lists the number of ID credits available for a project. The credits in this category are typically referenced in this book as “ID Cx” where “ID” represents “Innovation in Design,” “C” indicates “Credit,” and “x” represents the credit number. For instance, Credit 1 in the “Innovation in Design” category is referred to as ID C1.

Regional Priority (RP)

This last category of credits was introduced in 2009 in the new version LEED v3. This category promotes credits that have been identified as important to a particular region and are a priority for that region. In order to achieve these credits, project teams are not required to do anything other than achieve the credits that are marked as *regional priority* for their region. Six credits for each zip code have been identified and made

TABLE 1.6 LEED-NC INDOOR ENVIRONMENTAL QUALITY CREDITS		
CREDIT	TITLE	POINTS
Prerequisite 1	Minimum Indoor Air Quality Performance	
Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	
Credit 1	Outdoor Air Delivery Monitoring	1
Credit 2	Increased Ventilation	1
Credit 3.1	Construction IAQ Management Plan—During Construction	1
Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
Credit 4.3	Low-Emitting Materials—Flooring Systems	1
Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
Credit 5	Indoor Chemical and Pollutant Source Control	1
Credit 6.1	Controllability of Systems—Lighting	1
Credit 6.2	Controllability of Systems—Thermal Comfort	1
Credit 7.1	Thermal Comfort—Design	1
Credit 7.2	Thermal Comfort—Verification	1
Credit 8.1	Daylight and Views—Daylight	1
Credit 8.2	Daylight and Views—Views	1

available for project teams. Up to four points may be achieved under this category. These credits are typically referenced in this book as “RP Cx” where “RP” represents “Regional Priority,” “C” indicates “Credit,” and “x” represents the credit number. For instance, Credit 1 in the “Regional Priority” category is referred to as RP C1.

TABLE 1.7 LEED-NC INNOVATION IN DESIGN CREDITS		
CREDIT	TITLE	POINTS
Credit 1.1	Innovation in Design (specify title)	1
Credit 1.2	Innovation in Design (specify title)	1
Credit 1.3	Innovation in Design (specify title)	1
Credit 1.4	Innovation in Design (specify title)	1
Credit 1.5	Innovation in Design (specify title)	1
Credit 1.2	LEED Accredited Professional (LEED AP)	1

Impact of LEED Buildings

Since its inception in 1998, there have been several discussions among the building community regarding the real benefit of LEED buildings. There was no raw data available to verify the tangible benefits offered by LEED buildings, but in the past two years, a number of studies have provided significant evidence regarding the impact of LEED buildings, specifically in the areas of:

- Energy Performance
- Financial Returns
- Occupant Productivity
- CO₂ Emissions Reduction

ENERGY PERFORMANCE

A 2008 study¹¹ conducted by the New Building Institute (NBI) provides critical information regarding the energy performance of LEED buildings and whether they are performing as they were intended or designed to. Very rarely do building facility managers or design teams evaluate the performance of the building after construction is complete, and it is never really known if the systems are performing as they were originally meant to. The study by NBI analyzed the measured energy performance for 121 LEED-NC projects, and the results showed that LEED projects averaged *substantial energy performance* over non-LEED building stock. The metrics analyzed were (a) Energy Use Intensity (EUI), (b) ENERGY STAR ratings of LEED buildings, and (c) measured results compared to initial energy modeling.¹²

Energy Use Intensity (EUI)

The energy use intensity is a measure of total energy use normalized for floor area. This is used to compare the energy use of different buildings. Whole-building energy use is measured in kBtu (1000 British thermal units) per square foot, per year, to standardize units between fuels. The Commercial Building Energy Consumption Survey (CBECS) is a survey of building energy characteristics that is completed every four years by the U.S. Energy Information Administration (EIA). The CBECS provides information about the energy use intensities of the national building stock, and one way to know if a building is performing better, from an energy use perspective, is to compare it with this national building EUI data. The NBI study compared the EUI (in kBtu/sf/yr) to the CBECS national EUI data and found that “for all 121 LEED buildings the median measured EUI was 69 kBtu/sf, 24% below (better than) the CBECS national average for all commercial building stock.” Comparisons by building activity type showed similar relationships. For offices, the single most common building type, “LEED EUIs averaged 33% below CBECS.”¹³

ENERGY STAR Ratings of LEED Buildings

The ENERGY STAR program is a joint program run by the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) that rates the energy

performance of a building. To determine the performance of a facility, EPA compares its energy use with other, similar types of facilities on a scale of 1–100; buildings that achieve a score of 75 or higher may be eligible for the ENERGY STAR. The EPA rating system accounts for differences in operating conditions, regional weather data, and other important considerations. The NBI study found that “the average ENERGY STAR rating of LEED buildings was 60, compared with the median rating of 50 for the complete building stock.” However, the study also showed that nearly half of the LEED buildings had an ENERGY STAR rating of 75, meeting the qualification level of an ENERGY STAR building. Although there was a significant gap between the number of LEED buildings qualifying for ENERGY STAR and those that didn’t, it must be realized that at least 50% of the LEED buildings were performing better than non-LEED buildings. It obviously reflects the potential for improvements in the LEED rating system but signals that it is a step in the right direction.

Measured Results Compared to Energy Modeling

The LEED-NC rating system awards points in the EA category on the basis of the results of an energy simulation that compares the proposed building’s energy use with a baseline building. The simulation is done using the performance rating method—Appendix G of ASHRAE 90.1-2007 standard. The calibration of measured performance with the energy model predictions is a healthy indicator of whether the building is performing as predicted. The NBI study found that “measured energy savings averaged 28% compared to code baselines, which was close to the average 25% savings predicted by energy modeling in LEED submittals.”¹⁴

FINANCIAL RETURNS

Green buildings also afford substantial direct financial returns in terms of higher occupancy and rental rates, as was found by several recent studies. According to a 2008 study by the CoStar group, “LEED buildings command rent premiums of \$11.33 per square foot over their non-LEED peers and have 4.1% higher occupancy. Rental rates in ENERGY STAR buildings represent a \$2.40 per square foot premium over comparable non-ENERGY STAR buildings and have 3.6% higher occupancy.” It further states that “LEED buildings command \$171 more per square foot than non-LEED buildings.” The study also found that “LEED buildings had 3.5% lower vacancy rates and 13% higher rental rates than the market.”¹⁵

Another research study done by CB Richard Ellis and the University of San Diego in 2009 found that green buildings outperformed their non-green peers in key areas, such as occupancy, sale price, and rental rates, sometimes by wide margins. The results of the study indicated that there was a greater demand by property investors and tenants for buildings that had earned either LEED certification or the ENERGY STAR label.¹⁶

The present market downturn and recession in the economy have had an impact on the overall rental and sale values of properties, and the numbers, as reported by these studies, may have fallen. However, the business case for LEED buildings remains strong, especially because of the long-term benefits of reduced operating costs and the several government incentives for building green.

OCCUPANT PRODUCTIVITY

There have been many studies in the past that have linked improved indoor air quality and daylight to improved health and productivity of building occupants. In a study¹⁷ done by William Fisk for Lawrence Berkeley National Laboratory (LBNL), a survey of 100 U.S. office buildings, found that 23 percent of office workers experienced frequent symptoms of sick building syndrome (SBS) such as respiratory ailments, allergies, and asthma. The study indicated that the impact was usually hidden in sick days, lower productivity, and medical costs; but the economic impact was enormous, with an estimated decrease in productivity around 2 percent nationwide, resulting in an annual cost to the United States of approximately \$60 billion.

There are several other studies done by LBNL on the effect of daylighting on student performance. One case study, from a school located in San Juan Capistrano in southern California, indicated that students with the most daylighting in their classrooms progressed 20% faster on math comprehension and 26% faster on reading comprehension tests in one year than those with minimal exposure to natural light. Similarly, students in classrooms with the largest window surface areas were found to progress 15% faster in math and 23% faster in reading than those located in classrooms with a minimal window surface area. Students with well-designed skylights in the space improved 20% faster than students without skylights.¹⁸

While the above studies indirectly indicate that buildings that are designed with better indoor air quality and daylighting have a positive, direct impact on the productivity of occupants, the study by CB Richard Ellis (CBRE) and the University of San Diego provides information linking LEED buildings directly with occupant productivity. The CBRE report states that “tenants in green buildings experience increased productivity and fewer sick days.” The report backs up the results with numbers generated as a result of surveying 154 buildings, totaling more than 51.6 million square feet and housing 3000 tenants in ten markets across the United States. The report also found that tenants “reported an average of 2.88 fewer sick days in their current green office versus their previous non-green office, and about 55% of respondents indicated that employee productivity had improved. Based on the average tenant salary, an office space of 250 square feet per worker and 250 workdays a year, the decrease in sick days translated into a net impact of nearly \$5.00 per square foot occupied, and the increase in productivity translated into a net impact of about \$20 per square foot occupied.”¹⁹ Although the study included both ENERGY STAR rated and LEED buildings, what it found was indeed noteworthy in terms of the impact of *green* buildings.

CO₂ EMISSIONS REDUCTION

One of the primary needs for designing *green* buildings is to reduce their impact on the environment. According to the U.S. Green Building Council, buildings account for more than 72% of all electricity consumption, 39% of energy use, 38% of CO₂ emissions, 40% of raw materials use, 30% of waste output and 14% of potable water consumption in the United States.²⁰ The increasing use of energy by buildings has led to a depletion of fossil-fuel based resources as well as generation of greenhouse gas

(GHG) emissions. These GHG emissions have resulted in global warming that is causing the earth’s temperatures to rise at a dramatic pace. It is believed that the current global warming is at 0.7°C above preindustrial levels. Scientists predict that in order to avoid dangerous climate change, global warming must remain under 2°C above pre-industrial levels. Higher temperatures could cause catastrophic climate change.²¹

LEED buildings can help achieve significant reductions in GHG emissions, thereby controlling global warming and mitigating the effects of serious climate change. They are designed and operated to reduce electricity consumption, energy, water, and materials use. The Green Building Impact Report published in 2009 states that “annual CO₂ savings from LEED buildings was approximately 2.9 million tons from energy efficiency and renewables. This figure was expected to grow to 130 million tons per year by 2020 and almost 320 million tons annually by 2030.”²²

In summary, it can be seen that LEED buildings have had a significant impact in the areas of energy savings, financial returns, and occupant productivity. Figure 1.3 summarizes the findings of all the studies described in this section.

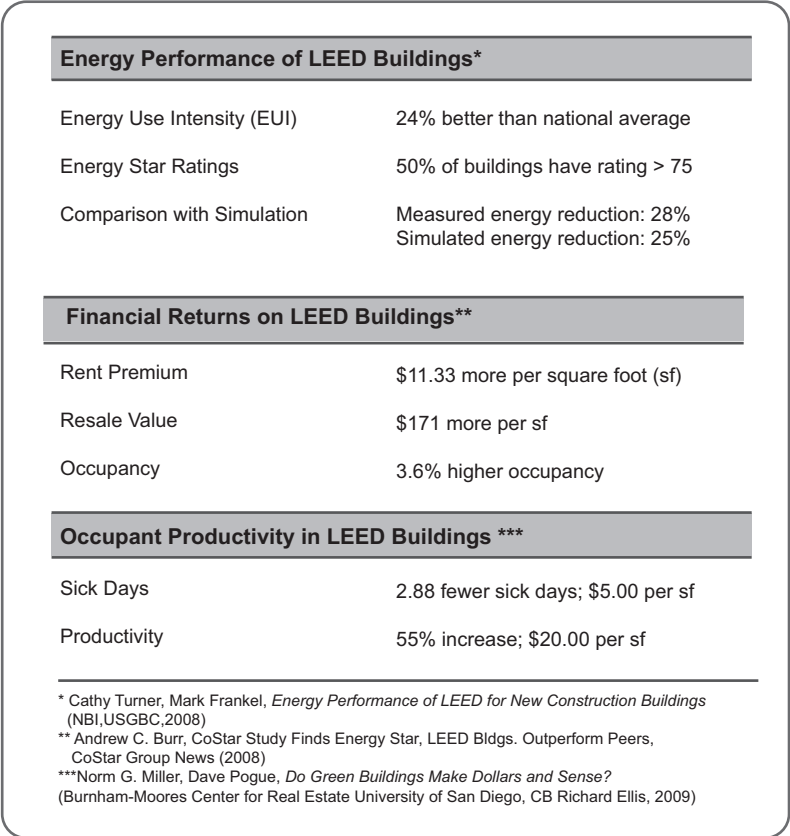


Figure 1.3 Impact of LEED buildings: energy performance, financial returns and occupant productivity.

What This Book Is About

This book is a beginner's guide for people who are new to LEED project management. It can also be used as a companion handbook by more seasoned professionals. The intent of this book is to become a go-to guide for architects, engineers, consultants, contractors, and LEED Accredited Professionals (APs) who are managing a LEED project. It is also an indirect resource for building owners, developers, and managers to understand what it takes to get a building certified.

Realizing the significance of the LEED rating system in shaping our modern-day building vocabulary, where the terms *green* and *LEED* are used interchangeably, we (members of the building community) must become better equipped to integrate the requirements of this rating system with our traditional building design processes. The LEED process requires high level planning, attention to detail, coordination, and management. In addition, the success of the certification is dependent on the integrity of the documentation provided to support the project's compliance with the rating system's requirements.

There has been an exponential increase in the number of LEED APs and an increasing number of projects that are registered with the USGBC to become LEED certified. A member update by USGBC in March 2010 stated that there were 27,358 registered projects of which a total of 4,890 had been certified. It was also noted that there were almost 140,218 LEED APs globally. These numbers indicate the tremendous potential of the LEED rating system in transforming and influencing the building community across the world. The fact that only a small fraction of the projects that were registered attained certification tells us the rigor that is needed by teams to achieve certification. This book gives readers a framework to take their projects to successful certification.

One of the many reasons that can be attributed to why projects fail to get certification is that they have not been managed any differently from traditional projects. The *LEED* element adds another dimension to the traditional project management model and requires careful integration into the overall design process. The growth in the number of LEED Accredited Professionals indicates that there will be a lot of freshly minted LEED APs trying to manage a LEED project without being equipped with tools for implementing a LEED project. Many design teams struggle with understanding the specifics of the LEED process. There is no defined methodology or roadmap available for actual implementation of a LEED project. While the USGBC provides a number of resources, including reference guides and workshops, to understand the LEED rating system, it does not necessarily outline steps or implementation processes. Most other available resources on LEED are books and online resources that are great references on general concepts of green, strategies to implement green, and also how to become LEED accredited. But many of these books fall short—there is no one “go-to” book that demystifies the LEED process, lays out a roadmap defining the various steps involved in a simplistic manner, and provides the necessary tools to implement a LEED project.

This book will provide step-by-step guidance to manage a LEED project to ensure that green requirements are integrated into the design and construction process. It will include steps, workflow diagrams, schedules, checklists, and sample documents—all

the necessary tools that will provide a framework for the LEED project manager to start, manage, and implement a LEED project. This book will tie the building design process with the GBCI's LEED certification process. This will, hopefully, generate widespread implementation of the LEED rating system, thereby bridging the gap between registered and certified projects.

What This Book Is Not

The intent of this book is to serve as a complimentary resource to the LEED Reference Guide provided by USGBC. Information regarding a credit's official intent and requirements should be sourced from the Reference Guide. This book is written assuming that the readers or users of the book have some level of familiarity with a credit's intent and requirements. Care has been taken not to repeat information that is already available in the Reference Guide, except for sections where further explanation of a particular process is required.

The book primarily focuses on implementation procedures for new construction projects that are specifically pursuing LEED-NC certification. The book is not directly applicable to LEED for Schools, LEED for Core & Shell (LEED-CS), LEED for Existing Buildings; Operations & Management (LEED EBOM), or any other green-building rating system. However, projects that are pursuing other types of certification may certainly be able to leverage information related to the processes, procedures, and general project management. The framework presented in this book is one of many that can be used to implement a LEED project. The author recognizes that there is no "one size fits all" solution on how to manage a LEED project. Every project is unique; and designs, schedules, teams, and delivery mechanisms vary with each project. The intent of this book is to present *a* defined set of implementation strategies, and there could be many variations of the method presented here.

The green building movement is rapidly evolving, and so are the different rating systems. This book is based on the LEED rating system that is applicable at the time of publication—LEED-NC v3. The intent is to present a set of management tools that can be adapted to changes in the rating system. Often the changes are made to the rating system requirements and not necessarily to the processes that define it; so this book should be scalable for rating system revisions in the near future.

Why Manage LEED Projects Differently?

The book is based on the premise that LEED projects should be managed differently from non-LEED projects. Before proceeding with the descriptions on how to manage LEED projects, it is important to understand why we need to manage them differently. For many decades, the process of building design and construction has been honed to

a science where each team member is cognizant of their roles in the overall process. However, the LEED process demands a commitment to questioning techniques and seeking new answers. Green building takes a whole system approach to design and requires early involvement of the design and construction disciplines to be successful. LEED is intended to improve building practices through transformation and innovation, and therefore requires that traditional methods of design and construction be revised and made more efficient. A LEED project requires additional considerations during the design, construction, and operation of the building. There are unique responsibilities and documentation requirements that are expected from the design team. For instance, a LEED project requires the use of energy modeling throughout the project to make informed design decisions. This can be considered as a *non-traditional*, yet useful practice that needs to be incorporated into the design process. By integrating these non-traditional practices into the design procedures, it is hoped that, eventually, these added responsibilities and requirements will become part of the regular design process. That will mark the true success of a rating system such as LEED in transforming the way buildings are designed. Below are some areas where a LEED project process differs from that of a traditional or a non-LEED building.

Design Decisions

A LEED project warrants a different approach to making design decisions, using tools that consider the interactions of the whole building and its impact on the environment. Decisions related to envelope, choice of HVAC systems, choice of materials, and choice of lighting are influenced by the LEED credit framework. Simulating the building's energy performance by means of a computer-generated model at every stage of design to come up with a design solution that optimizes the energy performance of the building is a requirement that is not usually part of the design process. Simulating the daylight levels inside a building to design the best possible fenestration strategy and coordinating it with interior lighting systems are other such examples. A LEED project requires preparing a comprehensive water budget that takes into account indoor water consumption along with outdoor irrigation needs as well as stormwater availability. For a building to achieve the true benefits of a green building, LEED requirements need to be integrated within the design from the beginning instead of being forced as an afterthought.

Construction Practices

The LEED rating system has given rise to a number of new construction practices and created a whole new set of responsibilities for general contractors and sub-contractors. A LEED project has significant impact on project costs, schedules, durations, and even project administration and contracts. In addition, there are procedures to be implemented on-site that are not typical construction procedures, such as recycling construction waste or implementing measures to manage indoor air quality.

Building Operations

In a LEED project, there are many aspects from an operational perspective that need to be considered early-on. The maximum benefit of LEED buildings is derived from

the operational savings associated with energy-efficient systems. Decisions during the design process need to be made with long-term operational benefits in mind. The rating system itself gives credit to projects that institute post-occupancy evaluations and measurement as well as verification procedures after construction is complete. Many management policies related to recycling, smoking, and alternative transportation may need to be developed and implemented by the building management. Traditionally, the building management's role in the building design process is fairly limited. However, while designing a LEED building, the management's input during design is important to ensure that the building is able to derive all the benefits associated with operational savings.

Team Member Responsibilities

The various team members working on a LEED project have additional layers of responsibility compared to those of a traditional project. The civil engineer and landscape architect may need to perform additional stormwater or irrigation calculations, the architect may need to write *green* specifications, or the mechanical engineer may need to create an energy model for the building. While some team members may lead the implementation of some credits, there are other team members who might need to support the implementation of that credit. Special consultants, such as LEED consultants, energy analysts, lighting consultants, commissioning authorities, IAQ specialists, and others, may be involved with the project. This requires increased level of coordination between the various consultants and team members to ensure the project's success.

Documentation

Finally, a LEED project requires diligent documentation of all activities to show that the project has met all the LEED credit requirements. Lack of clear direction as to what is required, from whom, and within what time frame can easily derail the process and delay certification. It has been observed that the necessity of providing documentation is a reason why project teams are wary of the LEED certification process. In reality, setting up documentation deliverables from the team right from the onset of the project and periodically reviewing them at various design and construction stages will simplify the process and make it more easily manageable.

How to Use This Book

This book is divided into two parts and each part is self-explanatory. The first part, Process, comprises the various steps and activities involved in managing a LEED project from pre-schematic design to construction completion and submission of the project to GBCI. The second part, Implementation, identifies activities that need to be completed by design team members to implement and document a specific credit. It also includes some credit sample documents that were submitted to USGBC by the teams of the case study projects described in Chapter 8.

PART 1: PROCESS

Chapter 1 Introduction

Chapter 1 provides a brief history of the green building movement, introduces the LEED Rating System developed by the U.S. Green Building Council (USGBC), and describes the impact it has had on the green building market in the United States and the world over. It also discusses the goals and aspirations of this book and how the readers can use and benefit from it.

Chapter 2 Project Management Process

Chapter 2 describes in detail the essential components of project management—process, people, and planning—the three pillars for a LEED project. It discusses the traditional design process, the GBCI certification process, and how the LEED project management process described in this book aligns with both. Three distinct stages are identified to manage the LEED process, and each of these stages is explained in detail in Chapters 3, 4, and 5 respectively. The chapter further identifies key roles and responsibilities of various design team members and outlines how LEED milestones may be integrated with the design schedule.

Chapter 3 Stage I: Project Definition and Goal Setting

Chapter 3 elaborates on the first stage of the process, which is to define the project and set goals. It identifies all key activities, tasks, and objectives of this first stage of the process.

Chapter 4 Stage II: Design Phase Integration

Chapter 4 describes the second stage of the process, which is to integrate green building and LEED requirements into the design process. The implementation steps and activities are aligned with the schematic design, design development, and construction documents phases of the design process.

Chapter 5 Stage III: Construction Phase Implementation

Chapter 5 describes the final stage of the process, which is to implement LEED credit requirements during construction. It identifies specific activities that need to be completed to document the project, and submit to GBCI.

Chapter 6 LEED Process: Adaptability, Applicability, and Best Practices

Chapter 6 identifies the benefits of implementing this project management process and provides best management practices for LEED projects. It also offers advice on how the processes described in this book may be adapted to different rating systems and building types.

Chapter 7 Future of Green: 2010 and Beyond

Chapter 7 identifies the importance of the LEED rating system in catapulting *green* to the spotlight over the last decade and provides a glimpse into the potential strategies,

technologies, and processes that could shape the green building movement in the coming decades.

Chapter 8 Success Stories

Chapter 8 provides an insight into how various, well-known projects have successfully achieved LEED certification. The chapter highlights the design process and green building strategies that were followed and offers key lessons learned from each project.

PART 2: IMPLEMENTATION

Section 1 Credit Implementation—Sustainable Sites

This section presents activities that the project team members may follow during the various phases of design to implement the requirements of credits in the *Sustainable Sites* category of the LEED-NC rating system. It also identifies team member responsibilities, documentation required, as well as tips and strategies to achieve a particular credit. The section also includes some sample documents from the case study projects described in Chapter 8.

Section 2 Credit Implementation—Water Efficiency

This section presents activities that the project team members may follow during the various phases of design to implement the requirements of credits in the *Water Efficiency* category of the LEED-NC rating system. It also identifies team member responsibilities, documentation required, as well as tips and strategies to achieve a particular credit.

Section 3 Credit Implementation—Energy and Atmosphere

This section presents activities that the project team members may follow during the various phases of design to implement the requirements of credits in the *Energy and Atmosphere* category of the LEED-NC rating system. It also identifies team member responsibilities, documentation required, as well as tips and strategies to achieve a particular credit. The section further includes some sample documents from the case study projects described in Chapter 8.

Section 4 Credit Implementation—Materials and Resources

This section presents activities that the project team members may follow during the various phases of design to implement the requirements of credits in the *Materials and Resources* category of the LEED-NC rating system. It also identifies team member responsibilities, documentation required, as well as tips and strategies to achieve a particular credit. The section further includes with sample documents from the case study projects described in Chapter 8.

Section 5 Credit Implementation—Indoor Environmental Quality

This section presents activities that the project team members may follow during the various phases of design to implement the requirements of credits in the *Indoor Environmental Quality* category of the LEED-NC rating system. It also identifies team

member responsibilities, documentation required, as well as tips and strategies to achieve a particular credit. The section further includes sample documents from the case study projects described in Chapter 8.

Section 6 Credit Implementation—Innovation in Design

This last section provides some examples of innovation credits achieved by the case study projects described in Chapter 8.

Notes

¹ Ethan Goffman, *Green Buildings: Conserving the Human Habitat* (CSA—Discovery Guides, 2006). <http://www.csa.com/discoveryguides/green/review2.php> (accessed February 8, 2010).

² Ibid.

³ David Gissen, *Big and Green: Toward Sustainable Architecture in the 21st Century* (New York: Princeton Architectural Press, 2002), 9.

⁴ Architecture 2030, “The Building Sector: A Hidden Culprit,” http://www.architecture2030.org/current_situation/building_sector.html (accessed February 10, 2010).

⁵ LEED is a registered trademark of the U.S. Green Building Council (USGBC); BREEAM is a registered trademark of Building Research Establishment (BRE); GreenGlobes is a registered trademark of ECD Energy and Environment Canada; GreenStar is a registered trademark of Green Building Council of Australia.

⁶ *USGBC Member Update* of March 2010 reported 18,000 Members; 140,218 LEED APs and Green Associates; and 27,358 Registered and 4,890 Certified LEED projects.

⁷ USGBC, “LEED Rating Systems,” <http://www.usgbc.org>.

⁸ USGBC, *LEED Reference Guide for Green Building Design and Construction* (USGBC, 2009), 161.

⁹ Ibid., 213.

¹⁰ Ibid., 401.

¹¹ Cathy Turner, Mark Frankel, *Energy Performance of LEED for New Construction Buildings* (NBI, USGBC, 2008).

¹² ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy.

¹³ Cathy Turner, Mark Frankel, *Energy Performance of LEED for New Construction Buildings* (NBI, USGBC, 2008), 2.

¹⁴ Ibid.

¹⁵ Andrew C. Burr, *CoStar Study Finds Energy Star, LEED Bldgs. Outperform Peers* (CoStar Group News, March 26, 2008). <http://www.costar.com/News/Article.aspx?id=D968F1E0DCF73712B03A099E0E99C679>. (accessed March 15, 2010).

¹⁶ Norm G. Miller, Dave Pogue, *Do Green Buildings Make Dollars and Sense?* (Burnham-Moores Center for Real Estate University of San Diego, CB Richard Ellis, 2009).

¹⁷ William J. Fisk, “Health and Productivity Gains from Better Indoor Environments,” in *The Role of Emerging Energy-Efficient Technology in Promoting Workplace Productivity and Health*, (Lawrence Berkeley National Laboratory, 2002).

¹⁸ Heschong Mahone Group, Lisa Heschong, “Daylighting and Human Performance,” in *The Role of Emerging Energy-Efficient Technology in Promoting Workplace Productivity and Health* (Lawrence Berkeley National Laboratory, 2002).

¹⁹ Norm G. Miller, Dave Pogue, *Do Green Buildings Make Dollars and Sense?* (Burnham-Moores Center for Real Estate University of San Diego, CB Richard Ellis, 2009).

²⁰ USGBC, “Green Building Research,” <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718>.

²¹Architecture 2030, “The Science: Converging Events,” http://www.architecture2030.org/current_situation/science.html.

²² Rob Watson, *Green Building Market and Impact Report 2009* (Greener World Media, Inc., 2009).