CHAPTER 8

Market Transformation

The Green Building Story

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A troubling economy found many companies turning to green buildings as a hedge against risk and stiff competition. Ten years earlier, no such market even existed. The story of green building's sudden rise in the United States, and in a sprawling industry notoriously hard to change, reflects the timely convergence of technology, expertise, and leadership to tackle compelling needs. But two catalysts proved vital in quickly building the critical mass that had ripple effects globally. The U.S. Green Building Council offered common ground to help integrate a fragmented industry, and its flagship program, the LEED green building rating system, found clever ways to enlist the mainstream market while engaging the leading edge. A broad set of business, social, and environmental drivers is now accelerating the market and triggering broad changes throughout the supply chain.

Challenges remain, such as the too-frequent divergence between designed and actual energy performance. Likewise, numerous market adjustments are needed to ensure that market transformation is commensurate with the speed, scale, and scope of global challenges. But the momentum behind this transformative wave is inexorable. International markets are heating up; elected officials are embracing green buildings to create jobs and cut greenhouse gas emissions; and new green building codes are redefining acceptable practice, even as "living" buildings are lifting expectations for what sustainability looks like in the built environment.

A Decade of Market Transformation

November 2009. In the midst of the worst economic downturn since the Great Depression, 27,400 building professionals descended upon Phoenix for the high-octane Greenbuild Conference and Expo. They found more than a hundred educational sessions, a thousand exhibitors, and headliners Vice

President Al Gore and Sheryl Crow—all hosted by the nonprofit U.S. Green Building Council (USGBC) and sponsors. Thousands paid extra to attend dozens of workshops on LEED—the rating system that is the de facto standard for green building in North America, India, and several other countries. Media were there in force. Energy levels could not have been higher.

Ten years earlier? GreenBuild did not exist. LEED was wrapping up a pilot test for its first product. There were no common definitions of what sustainability meant for a building in the United States, few such buildings to tour, and relatively few people who could design or build one.

How did green building take hold so quickly in an industry notoriously slow to innovate? Why was it a lifeboat for many firms when the construction industry was being hammered? Is it simply a trend or a deep market transformation? This chapter explores the vast impact of buildings, origins of the U.S. green building market, USGBC and LEED as change agents, key drivers and trends, and a glimpse into emerging issues as the market matures.

One Path to Green Buildings

My journey with green buildings began while serving as U.S. Assistant Secretary of Energy. The 1994 midterm elections found energy efficiency and renewable energy programs running into political buzz saws, partly because of entrenched partisan politics over energy policy. Few people outside our own arena seemed to connect clean energy with issues that people cared about—from environmental quality, water use, and public health to labor productivity, smart growth, and national competitiveness. Here were interests that could transcend politics as usual if we could find the right tools.

Two early conversations spurred my own "aha" moment for the tools we needed. One was a wintery conference call with leaders from the passive solar industry—who all passionately described benefits of holistic design and natural daylighting. Another was a wry observation from one of our own engineers: "If we designed airplanes like we do buildings, they'd never get off the ground!"

Clearly, a systems approach was key to unlocking a much wider stream of benefits. And it was a theme emerging from so many quarters—from the American Institute of Architects and Carnegie Mellon University to the Rocky Mountain Institute and a feisty new start-up called the U.S. Green Building Council.

Snapshot of the U.S. Buildings Sector

4.9 million commercial buildings

128 million residential units

9.2 percent of gross domestic product (GDP)

38.9 percent of all primary energy consumed

72 percent of all electricity

13.6 percent of all potable water

40 percent of all raw materials

49.1 percent of all greenhouse gases generated

170 tons of construction waste

Indoor air quality two to five times worse than outdoor air quality

1.2 percent of construction sales invested in research and development

3.2 percent of sales invested by all other industries (average)

Sources: U.S. Environmental Protection Agency (EPA), "Buildings and Their Impact on the Environment: A Statistical Summary," April 22, 2009, http://www.epa.gov/greenbuilding/pubs/gbstats.pdf; U.S. Department of Energy (DOE), "Buildings Energy Data Book," 2009, http://buildingsdatabook.eren.doe.gov/; and Architecture 2030, "Fact Sheet," July 19, 2010, http://www.architecture2030.org/downloads/2030FactSheet_published.pdf.

Why Buildings Matter

As Sir Winston Churchill famously observed: "We shape our buildings, and then they shape our lives." But even he might have been surprised at the degree to which the built environment shapes our economy, environment, and well-being.

Economy

Construction, renovation, and maintenance of residential and commercial buildings comprise nearly one-tenth of the $13.2 trillion U.S. GDP.[1] Overall, the construction industry employs 10 million people when infrastructure

projects are included: 7.2 million wage and salary workers and another 2.3 million who are self-employed.[2]

Environment

Perhaps because buildings are so commonplace, we do not recognize them as major sources of pollution and resource consumption—far more than necessary due to prolific inefficiency. Construction of the average house, for example, generates four tons of construction debris, although most of it could be recycled. More than 70 percent of the nation's electricity is consumed in buildings, but much of that energy is lost at production, during transmission, and in use.[3]

Quality of Life

Buildings have a profound impact on health, productivity, and well-being. Start with the fact that we spend 90 percent of our lives inside where air pollutant concentrations are typically two to five times greater than outside air.[4] Then factor in the growing body of research showing that features such as daylighting, ventilation, and natural landscapes—all common in green buildings—enhance worker productivity, health, and psychological well-being (Kats 2010).

Climate Change

Disruptive climate regimes affect all dimensions of life: economic, environmental, and social. Contrary to public perceptions, it is the built environment that generates the most greenhouse gas (GHG) emissions—nearly half of all emissions when operational and embodied energy uses are combined.[5] Worse, emissions are growing faster in buildings than any other sector.[6]

A Sector Ripe for Innovation

Given the magnitude of impacts, one would imagine that considerable research is invested in the building sector. Not so. The construction industry, including public works, invests less than 1.2 percent of sales in research and development compared with 3.2 percent for industry overall.[7] Federal appropriations allocated only 0.2 percent of funding to green building and related technologies from 2003 through 2005.[8]

Underinvestment is just one factor contributing to the sector's troubling inefficiency and productivity (NRC 2009). Extreme structural fragmentation is another major obstacle to innovation. Of the industry's 884,000 residential and commercial construction firms, for example, 68 percent employ fewer than five employees.[9] Imagine the challenges in sharing information across such a landscape, compounded by the use of hundreds of different design and modeling software tools. McGraw-Hill Construction estimates that the industry bleeds 3.1 percent of project costs, $36 billion a year, through software incompatibilities alone (2007). Still other factors are at play, including a patchwork quilt of regulations across the country and tax codes that discourage longer term investments. The good news? Those very flaws present vast opportunities for profitable innovation, which is exactly what the venture capital industry is discovering (Walsh, Urban, and Herkel 2009).

Emergence of U.S. Green Building Market: Harnessing the Innovation

Most "overnight" phenomena reflect lengthier back stories; green building is no exception. In a historical context, green design builds upon principles that predated the era of abundant fossil fuels and mechanical systems, when man drew upon wind, sun, and local resources out of necessity, if not choice. Detachment from those natural systems reached its climax during the 1970s energy crisis, when properties across the country tightened up to cut energy losses—often at the expense of daylighting, natural ventilation, air quality, and aesthetics. The results were so odious that some architects and engineers set about to find ways to enhance those lost qualities while preserving energy efficiency. Many became the pioneers of the contemporary green building market.

Today's bustling market reflects a confluence of the "right stuff" at the right time: impatient practitioners meeting market-ready technologies and prices; growing concerns over climate change, energy, and water presenting business opportunities; people wanting to make a difference. That being said, two "enablers" greatly accelerated the North American market with ripple effects overseas: USGBC and its flagship program, the Leadership for Energy and Environmental Design (LEED) system.

U.S. Green Building Council

USGBC's founding in 1993 provided a much-needed antidote to the highly compartmentalized building industry: a common meeting ground where

practitioners from every reach of the industry could fraternize, share ideas, and develop business partnerships. In fact, USGBC served as a support group for many of the early members who were lone, green champions in their jobs. Requirements for diverse industry representation on the board of directors and committees underscored the importance of integrating different disciplines even as they expanded USGBC's networks.

LEED

It is hard to overstate LEED's importance in catalyzing green building. Before LEED for new commercial buildings was formally launched in 2000, the U.S. market lacked broadly accepted tools for defining sustainability in buildings, certifying qualified buildings, fostering integrated design, educating clients and practitioners, or accrediting qualified professionals.[10] In short, vital tools were missing that could enable a seismic shift toward sustainability.

LEED's appeal in filling these voids was immediate with many early adopters. Over the next two years, hundreds of volunteers drafted LEED rating systems for a slew of other markets: commercial interiors, existing buildings, homes, core and shell, health care, schools, laboratories, retail, and neighborhood developments. All shared a common framework. First, project teams would need to meet one or two prerequisites in each of the five impact categories for new construction and major renovations: sustainable sites (26 points), water efficiency (10 points), energy and atmosphere (35 points), materials and resources (14 points), and indoor environmental quality (15 points). For example, all projects would need to have basic commissioning under the energy category. Second, teams could draw from a larger menu of optional credits paying attention to the intended objectives, best practices, and required documentation. Finally, bonus points were available for innovative concepts and use of a LEED-accredited professional. Ratings established were certified (40+ points), silver (50+ points), gold (60+ points), and platinum (80+ points).

Critical Success Factors

Various groups have used LEED as a model for ratings systems, with three features most commonly adopted.[11]

- Balance of Technical and Market Considerations. LEED seeks a reasonable balance between rigor and ease of use, recognizing that

adjustments come with market experience. Set the bar too high and risk missing a window of opportunity; set the bar too low and risk credibility as a leadership standard.

- Flexibility over Prescription. LEED's menu of optional credits offers generous flexibility to building teams—a feature that has proved crucial in engaging more than a niche market. Some have criticized this approach for cultivating a checklist mentality where teams chase points instead of good design. But LEED is a tool in the hands of users—not an end in itself. So far, benefits from flexibility have far outweighed risks.
- Multiple Tiers of Recognition. While certified is readily feasible for the mainstream market, the platinum end of the spectrum engages market leaders. The Olympic-style framework also stimulates competition and market differentiation.

Several institutional factors, not so easily replicable, also boosted LEED's potency in quickly getting traction.

- Early Momentum. Influential early adopters—none greater than the federal General Services Administration—generated a critical mass upon launch of LEED. Strong momentum also dampened interest in competing certification systems that could have splintered a fledgling market.
- Leadership Credibility. Because LEED is shaped and practiced by recognized leaders in the field, including many with strong environmental credentials, its mantle of authenticity draws a measure of market patience and forgiveness not always enjoyed by others.[12]
- Financially Robust Business Model. Most organizations require grants to offset costs associated with certification—particularly those addressing complex, living ecosystems such as fisheries and organic agriculture. Even with LEED, certification costs can exceed fees. But training and accreditation opportunities for this large, horizontal industry more than compensate, giving USGBC tremendous financial capacity to fund more than 200 staff and $100 million in support of education, research, advocacy, and grants.[13]

LEED's Evolution

The ability to market LEED-certified new buildings to tenants was instrumental in engaging the U.S. real estate market. But can any new building be certified green without postoccupancy data to demonstrate its performance? That question dogged LEED-New Construction ever since its launch and intensified as various studies and anecdotal reports found mixed correlations between design and measured performance (Turner and Frankel 2008). As part of a climate change initiative in 2008, USGBC tackled the problem by requiring that all new construction either go through biannual recertification, provide energy- and water-use data for five years, or give USGBC direct access to utility data. Will plaques be withdrawn if requirements are not met? How will developers respond? Questions remain, but the direction is clear: certified green must mean operating green.

By 2009, the LEED system needed a major upgrade to manage explosive growth. New commercial construction was already reaching 10 percent of the market with 4,500 certified projects and 17,000 projects covering about 7 billion square feet. Likewise, the relatively new residential and neighborhood development products were getting serious traction. Finally, wide adoption among 41 states, 270 local governments, and the federal government meant that LEED activity was going nowhere but up.[14]

All project certifications and professional accreditation now would be administered by the affiliated but independent Green Building Certification Institute. Online services were beefed up. All the differing rating systems (except homes and neighborhoods) were normalized into a common 100-point system for LEED 2009. Bonus points were added for credits deemed as regional priorities. The most substantive change, however, came through USGBC's adoption of a transparent, formal system for weighting credits according to impacts.[15] As a result, LEED 2009 greatly increases the number of points addressing climate change, energy efficiency, and water while decreasing relative emphasis on materials and indoor environmental quality.

Market Transformation Drivers

No matter how powerful LEED may be as a market enabler, it is the underlying value proposition that drives this exuberant market. Deutsch Bank's real estate research arm, RREEF, put it best: "Green building is fundamentally altering real estate market dynamics—the nature of product

demanded by tenants, constructed by developers, required by governments and favored by capital providers" (RREEF 2007, 3).

Improving the Bottom Line: Cutting Expenses

Long one of the top drivers, tenant interest in cutting energy, water, and other operating expenses ratcheted up during the recession. This motivation will only increase with rising energy costs, water shortages, and trends toward disclosure of a building's performance.

Boosting the Top Line: Investing in People

The ability to attract, retain, and boost the productivity of talent is top of mind for most executives. Personnel costs typically comprise 80 percent of total building costs over 30 years, so small productivity gains can quickly translate into higher profits. Now factor in growing awareness that green building features, such as natural daylighting and good ventilation, can boost productivity and employee satisfaction—even patient recovery and student performance—and the "people factor" plays into growing demand (Kats 2010).

Tenant Demand and Market Competitiveness

Increased tenant demand for green property has been reported for years. Until recently, however, it was not clear whether that translated into higher rents. A landmark 2008 analysis found that 1,300 Energy Star and LEED buildings did tend to command higher rents, occupancy rates, and lower turnover than conventional buildings, although additional research is still needed (Muldavin 2008).

Public Policy

As early adopters, the public sector continues to play an enormous role in green building, comprising nearly 30 percent of all LEED buildings.[16] But government has additional tools for influencing private development. Popular "carrots" include tax credits, expedited permitting, zoning allowances, and reduced development fees. Portland, Oregon, employs a combination "fee/bate" system that fines developers for just meeting code and that rewards those who greatly exceed code. Washington, D.C., and Boston were the first cities to impose LEED-based requirements. In 2008,

California led the nation in adopting the first statewide green building code, roughly comparable to LEED silver (see section on codes below).

Supply Chain Ripple Effects

Think of buildings as products with hundreds of components—each of which has the potential to meet criteria reflected in LEED and other rating systems (e.g., recycled content, certified to avoid off-gassing). Demand for green buildings is cascading into new markets for green products and materials throughout the supply chain, serving to lighten the environmental footprint of the whole sector (Watson 2010).

Jobs, Jobs, Jobs

Economic opportunities arising from green building has not gone unnoticed by elected officials. A 2009 study by Booz Allen Hamilton for USGBC predicted that green building would support or create 7.9 million jobs between 2009 and 2013, contributing $554 billion to the U.S. GDP.[17]

Climate Change

Climate change is an accelerant to all the preceding drivers. Well-publicized analyses from Architecture 2030, McKinsey & Company (2009), and the United Nation's Sustainable Construction and Building Initiative (SBCI 2009) spread awareness that buildings are the single best opportunity for large, fast, affordable emission reductions. The widely endorsed 2030 Challenge, for example, presented strategies for making the built environment carbon neutral by 2030 by ramping up energy efficiency into each annual construction and renovation cycle (starting with 50 percent efficiency gains in 2010). Only aggressive adoption of codes can lock in such performance; but voluntary standards such as LEED help "lubricate" their political feasibility. No wonder green buildings are finding such enthusiastic support from governors, mayors, and college presidents.

Recent Trends in U.S. and International Markets

While numerous incentives are driving the green building market, classic barriers of perceived risk, lack of information, and cost premiums are falling away. The result is manifest in U.S. and global markets.

Greenbuild: Mainstreaming Green

Shortly after arriving at USGBC in 1999, I met with a fund-raising consultant to help secure foundation grants. But her first question had nothing to do with grants: "You only have annual meetings for members? What about reaching out to the mainstream industry—isn't that USGBC's mission?"

Over the next two years, we created an international conference and trade show proposal that would reach a broader audience but serve our members too. We needed a partner—but met obstacles. Some wanted too much revenue; others did not fit our mission; another was lukewarm, thinking we should lower our expectations. We went our own way.

November 2002—in the aftermath of 9/11 and travel cutbacks—was not an auspicious time to launch a new event. Still, our target for Austin was 2,200 attendees and 200 exhibitors. The day before opening, however, an unexpected problem arose: too many people were registering for the space we rented! We would have to cut off attendance at 4,200. That set the tone for the week: 80 sessions, 220 exhibitors, 26 countries, exhausted exhibitors—wishing they had staffed up more for this information-hungry crowd.

Each year has brought more people, more exhibits, more "Main Street" converging with "Green Street." One thing remains constant though: a passionate, wildly enthusiastic crowd eager to change the world.

Commercial Buildings

In the commercial market, LEED's longstanding target has been to secure the top 25 percent of new building space. Based on the market value of activity, that goal may already have been reached in 2010—years earlier than originally forecast. Moreover, market activity is projected to reach 40–48 percent by 2015, equating to a $120–145 billion opportunity (McGraw-Hill 2010). Set against the backdrop of a slow-to-innovate industry and the economic downturn, this is market transformation on adrenalin. Perhaps most encouraging, however, has been the surge of interest across the vast landscape of existing buildings where LEED engagement has been growing nearly 80 percent for several years running (Watson 2010). In fact, 2010 was the turning point for LEED to register and certify more existing floor

space in the United States than all forms of new construction combined. Astute industry analysts would not be surprised. As one concluded in early 2009, "Ignoring this impending market transformation would be risky and imprudent, and the current recession will provide little cover to owners failing to adopt" (RREEF 2009).

Residential Buildings

Similar growth trends are under way in the residential sector, although the terrain is populated by 70 local programs existing alongside relatively new national programs (e.g., LEED for Homes and the National Homebuilders Association's Green Building Standard). For LEED itself, 10,000 projects had been certified by early 2011, 59 percent of which were "production" homes built by the country's largest homebuilders (Watson 2010). While the impact of the recession is still unfolding, consumer interest clearly is growing. A 2008 survey found that 70 percent of home buyers would be more inclined to buy a green home during a down economy, primarily for lower utility bills and a healthier environment (McGraw-Hill 2010). Home sales data in the Seattle and Portland areas back up survey findings: certified green homes are trending toward ever-increasing shares of new home sales, higher price premiums per square foot, and less time on the market (Kaufman 2010; Griffin 2010).[18]

Neighborhoods and College Campuses

It was a marriage waiting to happen: green building, smart growth, and new urbanism. The engagement began in 2002, when USGBC, Natural Resources Defense Council, and Congress for New Urbanism began work on LEED for Neighborhood Developments (LEED-ND). In 2009, the finished product was released after a three-year pilot that attracted 250 pilot projects across the country. As of early 2011, 72 projects had achieved certification with another 160 in the registration process. Regardless of how many individual projects and square feet wind up certified, LEED-ND may well prove to be most potent as an urban planning tool for local governments.

Not surprisingly, many colleges and universities were early adopters in green building and continue to work on the leading edge. Aside from their role in owning and operating sizeable swaths of real estate, research and teaching missions make them quintessential living laboratories for sustainability. With 725 LEED certified projects in 2010, higher education

averages more than 10 percent of the nation's certified buildings with several thousand more projects registered. Like other registered projects, it is difficult to determine what percentage will carry on through with third-party certification. Many campuses have projects based on LEED or Green Globes and monitor conformance through self-assessments. Likewise, both certified and self-assessed buildings are often recognized in the growing number of campus sustainability tracking systems and report cards.

International Markets

Activity in the World Green Building Council (WGBC), a forum to share best practices among councils patterned on the USGBC model, is the single best window into global trends. In 2007, there were a dozen national councils; three years later, there were 23 established councils and another 35 in various stages of formation. Councils vary considerably according to conditions on the ground. Poverty and affordable housing are dominant issues for some councils; explosive urbanization and environmental damage preoccupy others. Nonetheless, this business-oriented model is finding global traction.

Rating systems also vary by region with LEED (which currently accounts for about 20 percent of all registrations and certifications), the British Research Establishment's Environmental Assessment Method (BREEAM), and Australia's Green Star being most prevalent. These and other emerging systems will undoubtedly learn from each other even as they increasingly tailor them to meet local conditions. This trend toward "common but differentiated systems" is evident in two projects. In 2009, a consortium of organizations including the United Nations, USGBC, British Research Establishment (BRE), and Australia's Green Building Council developed the common carbon metric to measure and report GHG from building operations. The Paris-based Sustainable Building Alliance also leads a coalition, including the World Green Building Council and the United Nations Environment Program, to develop a broad set of other impact metrics that can then be interpreted across rating systems. Snapshots of two influential markets follow.

Europe

Is Europe more advanced than the United States in high-performance buildings, as is often suggested? A recent survey of European building practices found a good deal to commend: many technologies and building energy

labels that are only recently finding their way into North American practice; the 1990 advent of the influential BRE rating system (BREEAM); more prevalent use of engineers in integrated design; strict codes for daylighting and natural ventilation to promote worker health and well-being; and the German-Austrian PassivHaus housing concept that pushes the envelope in minimizing energy use and technology innovation (Yudelson 2009). Such findings are not surprising, given that Europeans tend to support more building research, higher energy prices, longer-term investments, and more regulations than the United States. Given the cultural bent toward voluntary measures in the United States, strong business leadership and government incentives will be necessary to close the gap with Europe's performance.

China

The future of green building in China may very well determine whether global climate change strategies will win or fail. China matters because

- 80 percent of global greenhouse gas emissions in China stem from urban areas.
- 350 million Chinese will move to cities by 2030—more than the entire population of the United States.
- 50 percent of the world's new construction will occur in China by 2015 (McKinsey Global Institute 2009).
- By 2025, 50,000 skyscrapers will be built in China—the equivalent of about 10 cities the size of New York City.

Fortunately, China's green building market is among the world's fastest growing. In 2008, green building was valued at about $40 billion—up from $10 billion in 2005—and projected at more than $100 billion by 2013 (McGraw-Hill 2010). China's early market was nurtured by multinational corporations that brought their facility standards with them. But national priorities are now driving China's market, as reflected in the emergence of a national green building council and government-adopted, three-star rating system.

Market Transformation: Theory in Practice

Voluntary programs such as LEED and Energy Star trigger the cycle of market transformation when they catalyze innovation at the leading edge

of the market. When successful best practices reach critical mass, in theory, they are adopted in codes and standards—essentially raising the floor. That in turn inspires market leaders to innovate at the leading edge again.

In reality, the cycle of continuous advancement can be lethargic or broken. Voluntary bars can be set too high for triggering a critical mass or too low for stimulating innovation. Timing may be off. Incentives may not work. Too many voluntary standards can splinter or confuse the market for concerted traction to occur. But theory is meeting reality in the virtuous circle of green building market transformation.

Raising the Floor

In mid-2008, California launched the nation's first mandatory green building code for new construction effective in 2011. Meanwhile, two national efforts came together on March 15, 2010, when the International Code Council and partners celebrated release of the International Green Construction Code for public comment, making it available for adoption by 50 states and 22,000 local jurisdictions much like their model energy codes over several decades.

Because the codes are roughly equivalent to LEED silver, and because nearly 60 percent of current LEED certifications are either certified or silver, some registered projects could choose not to proceed with certification in jurisdictions with codes. Does that undermine LEED? Not if the goal is market transformation. The advantages of uniform adoptable and usable and enforceable green codes are too compelling. Besides, many of the same drivers for third-party certification will continue. The greater risk is that local jurisdictions focus exclusively on energy codes without an integrated framework to capture other benefits from green buildings. It will be up to the green building industry to make an integrated package too compelling to ignore and to keep the cycle of innovation moving.

Lifting the Ceiling

What lies beyond platinum and incremental progress toward sustainability? The Living Building Challenge (LBC), launched in 2006, explores the highest level of performance possible in today's environment. LBC asks: "What if every single act of design and construction made the world a better place?" It is this aspect of buildings as restorative parts of the landscape and community that defines the leading edge of sustainability thinking today.

Given LBC's objective to define sustainability in absolute terms, all 20 credits are imperatives (e.g., buildings must generate their own energy, capture and treat their own water). Certification also requires one year of occupancy and operation to verify performance. The first challenge attracted considerable interest with about 70 project teams signing up; 3 projects were certified in 2010 and 2 others on track for certification in 2011. Version 2 added sections for equity and urban agriculture and included a framework adaptable for renovations, landscape and infrastructure, and neighborhoods and campuses.

LEED and similar systems will no doubt draw from such efforts as they ratchet upward. A gap will remain between the two kinds of standards indefinitely—in part because USGBC's consensus-based membership would not likely approve quantum leaps. Besides, the objectives are different between an absolute measure of sustainability and a tool for moving mainstream markets. Both are vital in the cycle of market transformation. The advantage of having multiple tiers, of course, is that some future platinum level could well be redefined in absolute or more prescriptive terms.

Emerging Trends

Several trends will shape the speed, scale, and scope of greening the built environment. Among them will be the need to focus on the behavior of a building's occupants as well as the transparency and meaning of "green" labels.

Beyond Technology to Behavior

With the spotlight on delivered performance, emphasis is shifting from design and technology alone to the workaday world of operations and human behavior. The new rock stars of tomorrow's green buildings? Commissioning agents, facility managers, and engineers—along with product and building designers who love to collaborate with operational specialists.

Transparency

Europe pioneered the use of green product labels in the 1970s and building labels in 2002 (the Energy Performance of Buildings Directive). In true American style, a cacophony of different tools is emerging here. California, Washington, D.C., and Austin, Texas, are among first movers to require

disclosure of energy use to prospective buyers. The American Society of Heating, Refrigeration and Air-Conditioning Engineers has launched a building energy quotient label for commercial buildings, and the Earth Advantage Institute has advanced a residential version being rolled out in Washington, Massachusetts, Virginia, and Alabama under a federal grant. Meanwhile, the Department of Energy and EPA are exploring these and other models for a national version. Clearly, convergence toward common platforms will accelerate a fully engaged market including financial institutions and the appraisal industry.

Green Labels and Life Cycle Analysis

Green building programs helped trigger booming markets for green products and materials and, with them, a raft of private and nonprofit certification systems. In turn, a lively discussion has ensued about whether and how to harmonize the disparate programs (Committee on Certification and NRC 2010). A concurrent trend is to find practical ways to incorporate life cycle analysis (LCA) information into product and building rating systems (e.g., measuring total environmental impacts from creation through disposal and reuse). European systems, LEED, and Green Globes are grappling with this, as is the multi-stakeholder Sustainability Consortium including Walmart and other retailers and manufacturers. The key challenge is streamlining the analysis to the most relevant indicators so LCA does not collapse under its own weight.

Information Technology Meets Green Building

Like the rest of society, information technology (IT) is already changing the way we design and operate buildings. Building information modeling offers powerful simulation capacity for designers and engineers. Real-time, user-friendly information and control technology is migrating to facility managers and home owners alike. Conversely, with increasing dependence on IT, the energy and water requirements for data centers are increasing rapidly. In 2008, a Silicon Valley business coalition working with the Lawrence Berkeley Laboratory drafted a proposal for applying LEED to data centers for USGBC's consideration. Nonetheless, an integrated approach to IT products, peripherals, and data centers as an ecosystem will be necessary to harness IT on behalf of sustainability.

Ecodistricts and Ecocities

No doubt many cutting-edge approaches for more sustainable, carbon-neutral living will be honed in the new cities rising in China, India, and Abu Dhabi. Clever concepts for integrating resources and planning are found in European "ecodistricts," and those just getting under way in places like Portland. Sometimes, the most clever thing can be replicating commonsense approaches such as cogeneration plants found in dozens of cities.

Nature as Mentor

The field of biomimicry points designers and engineers to the ultimate source of innovation—nature—for guidance in shaping a regenerative built environment. New products directly inspired by biomimicry already have emerged for application in the building sector including self-cleaning paints inspired by the lotus flower, nonformaldehyde adhesives inspired by mussels, and high-efficiency motors and turbines inspired by spiral shapes.[19] But concepts are scalable to whole buildings and communities as more building professionals start collaborating with biologists.

Conclusion

Today's built environment did not happen because people wanted low-performing, wasteful, unhealthy buildings. It evolved in large measure because our markets discount the future and interdependencies with natural systems. But today's green building market has stirred the public's imagination—and appetite—for an alternative built environment: one that sustains and restores people, business, and ecosystems. Its vitality in the face of a weak economy has laid down a loud, cheerful rebuttal to arguments for delay.

As a case study, the green building story offers practical insights. USGBC reminds us that unlikely private–public coalitions can overcome historical barriers to innovation; leadership in either sector alone would not have triggered or sustained this revolution. LEED reminds us that shiny, new technology and scientific data alone will not trigger deep transformation; humans need tools to make change easier. More broadly, the green building story reminds us that codes and clever rating systems

will take us just so far. The best way to bring sustainability to speed, scale, and scope is to empower markets with "full value" price and information signals that reach into every nook and cranny of the huge, complicated, lumbering building sector.

If there is a comforting implication of today's challenges, it is that human ingenuity is unleashed by working against limits. Today's efforts to help define and create a vibrant, restorative built environment are proof positive.

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Notes

1 U.S. Department of Energy (DOE), "Buildings Energy Data Book," 2009, http://buildingsdatabook.eren.doe.gov/

2 U.S. Bureau of Labor Statistics (BLS), "Career Guide to Industries. 2010–11 Edition," http://www.bls.gov/oco/cg/cgs003.htm

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5 Most governmental data depict residential and commercial buildings generating 39.0% of U.S. GHG emissions. Architecture 2030 includes energy use from industrial buildings plus energy embodied in construction materials. This

simple accounting change has had tremendous impact in presenting a complete snapshot of the building sector's role in climate change. U.S. Environmental Protection Agency (EPA), "Buildings and Their Impact on the Environment: A Statistical Summary," April 22, 2009, http://www.epa.gov/greenbuilding/pubs/gbstats.pdf; U.S. Department of Energy (DOE), "Buildings Energy Data Book," 2009, http://buildingsdatabook.eren.doe.gov/; and Architecture 2030, "Fact Sheet," July 19, 2010, http://www.architecture2030.org/downloads/2030FactSheet_published.pdf.

6 Architecture 2030, "Fact Sheet."

7 DOE, "Buildings Energy Data Book."

8 U.S. Green Building Council, "A National Green Building Research Agenda," 2007 (rev. February 2008), http://www.usgbc.org/ShowFile.aspx?DocumentID=3402

9 BLS, "Career Guide to Industries."

10 Three other rating systems helped inform LEED development but were not broadly available to the U.S. market: the British Research Establishment's Environmental Assessment Method (BREEAM) established in 1990 and now used widely in the United Kingdom and other countries; the international Green Building Challenge; and the local green building program in Austin, Texas.

11 Examples include the American Society for Landscape Architect's SITES program, the EPEAT standard for electronics administered by the Green Electronics Council, and STARS for transportation projects being developed by a consortium of planners in the Pacific Northwest.

12 The Green Globes rating system, affiliated with the Canadian branch of BREEAM and administered in the United States by the Green Building Institute, has met stiff resistance from many green building leaders in part because it was supported by companies and organizations who lobbied against governmental adoption of LEED in early years. The organization is now accredited by the American National Standards Institute, is recognized in various states and cities, and offers online self-assessment and on-site third-party certification.

13 Personal communication with Chris Smith, USGBC's chief operating officer, April 8, 2010.

14 "Policy and Government Resources Fact Sheet, 2011," *U.S. Green Building Council*, 2009, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1779; and McGraw-Hill (2010).

15 LEED 2009 reflects the National Institute of Standards and Technology weighting methodology for impact categories defined by EPA.

16 "Policy and Government Resources Fact Sheet, 2011."

17 Ibid.

18 In Seattle, Energy Star, LEED, and Built Green–labeled homes carried a 9.1 percent price premium per square foot over a three-month window and stayed

on the market 24 percent less time than conventional homes. In Portland, higher price premiums for certified existing homes ranged from 10 to 32 percent in five counties.

19 Biomimcry Institute, http://www.biomimicryinstitute.org/