Balancing commercial and environmental interests through green building design

Spring 2011
About the China Greentech Initiative

Founded in 2008, the China Greentech Initiative (CGTI) Partner Program has rapidly grown to become the only China-international collaboration platform of 100+ organizations, focused on identifying, developing and promoting green technology solutions in China. Partnering organizations are technology buyers and sellers, service providers, investors, policy makers and influencers. Sector tracks addressed during the 2011 CGTI Partner Program include Cleaner Conventional Energy, Renewable Energy, Electric Power Infrastructure, Green Building, Cleaner Transportation and Clean Water.

Built on two cornerstones, strategic market research and a community of 300+ industry experts, CGTI provides participating organizations with three core areas of benefit: world class market insights that enable better decisions, meaningful relationships that lead to business opportunities, and thought leadership and education that position participants as leaders in China’s greentech markets.

In addition to the Partner Program, CGTI offers Advisory Services, conducts briefings and publishes public content, including White Papers and the annual China Greentech Report. The flagship China Greentech Report 2009, released at the World Economic Forum, together with the China Greentech Report 2011, have more than 75,000 copies in use globally and have helped establish CGTI as the authority on China’s ever evolving greentech markets.

Green Building Sector Definition

The China Greentech Initiative defines Green Building as planning, building and operating solutions that are more sustainable, efficient and healthy than conventional solutions for an equivalent level of comfort and service throughout all stages of a building’s lifecycle.

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Activities

- Eco city program
- Rural building plan
- Green building certification
- Green civil contracting
- Building automation system
- Energy management system
- Indoor environment
- Building efficiency retrofit
- Subsidy programs
- Heat reform
- New building standard
- Prefabricated housing
- Intelligence home system
- Facility management
- Appliances green labeling
- Interior retrofit

Products

- Power supply
- Water supply
- Construction material
- Building envelope
- HVAC
- Cabling
- Fire and security
- Furniture
- Distinct heating
- Gas supply
- Renewable products
- Plumbing
- Intelligence building control
- Lighting
- Sanitary ware
- Appliances

Source: China Greentech Initiative analysis
Executive Summary

China’s tremendous conventional and green building growth, mounting environmental strains and strong regulatory support imply high market potential for green building design, but stakeholders must first embrace integrated design principles and overcome widespread flaws in current design practices.

To respond to environmental strains brought about by a burgeoning building stock, China’s government is extending favorable policies for green buildings in the 12th Five-Year Plan (2011-2015). The mandates and incentives issued by the government have been indispensible drivers of green building design in China, and the market experienced 25% growth in green building certifications in the first quarter of 2011.

However, while the market has grown rapidly, design practices are still playing catch-up. Lapses in integrated design have placed green buildings at risk of falling short in actual operations. Stakeholders must overcome a number of common challenges to accelerate the adoption of green building design, including data gaps in energy simulation models, issues with local design institutes, insufficient industry expertise, inadequate post-construction monitoring and difficulty in sourcing green building materials. Green building design techniques, which include labeling systems, passive design, Net Zero energy design and intelligent building, can integrate green building technologies to achieve environmentally and commercially sustainable objectives. Case studies and insights from building professionals bring to life green building design challenges, and offer innovative solutions.

Definition and Scope

Optimal green building design delivers high environmental performance while also being commercially feasible for developers and appealing to end-users.

This White Paper evaluates conventional building design practices and advanced green building design techniques, identifies green building market trends, pertinent regulations, standards and decision-making process challenges, and identifies steps stakeholders can take to accelerate the adoption of optimal green building design in China. The White Paper focuses on high-rise LEED and 3-Star public buildings. Less focus is given to residential buildings, and no focus is given to industrial building and corporate policies.
Regulatory and Market Context

Despite challenges, green building design techniques have large potential in China’s rapidly growing market.

Green buildings are essential for balancing China’s development and environmental goals

China’s expanding building industry has a large environmental footprint: Buildings currently account for approximately 20% of China’s primary energy consumption, 30% of China’s electricity use, and cause roughly half of all urban carbon emissions. Buildings consume 74.8 billion metric tons of potable water every year, nearly 50% of China’s supply, and produce 35.5 billion metric tons of municipal wastewater. As a major contributor to municipal solid waste, building construction generates 45-60 million metric tons per year, or 30-40% of China’s total. These figures will continue to grow with increasing urbanization.

The Chinese government has viewed green buildings as a means to balance its development and environmental goals. While conventional design emphasizes cost, quality and other traditional parameters, optimal green building design balances these parameters with building functionality, features and materials to deliver high commercial and environmental performance. Green building design also considers building constraints such as timeframe, budget and location within the context of energy, land and water use.

Accelerating growth and regulatory support underlie the market

Urban commercial and residential building construction is increasing rapidly in China: Newly-constructed floor space exceeded 3 billion square meters in 2009 and is projected to surpass 3.5 billion square meters by 2012. Commercial construction overtook residential construction in urban China for the first time in 2009 following actions taken by policymakers to slow growth of the residential market.

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4 National Statistics Bureau, “China Statistic Yearbook 2010,” 2010
5 China Greentech Initiative (CGTI) analysis
Aggressive regulatory targets and incentives created by the Ministry of Housing and Urban-Rural Development (MOHURD) as part of the 12th Five-Year Plan will accelerate the green building market. For example, MOHURD has mandated that newly constructed buildings reduce energy consumption by 65% compared to the existing building stock, which previously called for 50% reductions. Other supportive policies include an expansion of district heating reform and energy conservation in large public buildings, and subsidies for highly-rated 3-Star buildings up to RMB 75 per square meter (the subsidy depends on the incremental cost of improvements).

The pace of green building construction and certification is quickening

From 2008 to the first quarter of 2011, U.S. Leadership in Energy and Environmental Design (LEED) and China’s domestic green building evaluation system, 3-Star, certified a total of 194 green buildings in China. Approximately 25% of these buildings were certified in the first quarter of 2011, mainly driven by the growth in China’s 3-Star certifications.

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6 Lawrence Berkeley National Laboratory, Assessment of China’s Energy-Saving and Emission-Reduction Accomplishments and Opportunities During the 11th Five-Year Plan, (Berkeley, CA: Lawrence Berkeley National Laboratory, 2010)
7 CGTI analysis
While green building growth has been impressive, the geographic reach of green buildings remains limited. Just eight cities account for 92% of all green buildings in China, and three of those cities—Beijing, Shanghai and Suzhou—make up over 50% of the total.\(^\text{10}\)

In the second quarter of 2011, 3-Star surpassed LEED in green building certifications,\(^\text{11}\) a trend which may be explained by building type and ownership. LEED certifications dominate the industrial segment, and are often owned by international companies adhering to internal sustainability standards. In contrast, 3-Star certifications dominate the residential segment, where local players are more likely to award projects to domestic developers.

**Integrated Design**

For green buildings to fully capture environmental benefits and become commercially attractive, the market must first embrace integrated design and dispel deficiencies in prevailing design practices.

**Integrated design can be difficult to implement in China**

Decisions in conventional design are made to maximize quality and minimize cost within project constraints. Specialization among building disciplines can increase efficiency, but can also impede the open and frequent dialogue necessary to implement integrated design. This is exaggerated in China, where Local Design Institutes (LDIs)—state-licensed, third-party institutions—design and approve all

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\(^\text{10}\) CGTI interviews and analysis  
\(^\text{11}\) CGTI analysis
buildings in China. LDIs tend to centralize and control technical aspects of building design, including structural, electrical and mechanical engineering. Integrated design may be more difficult to achieve if the project design team and LDI remain as separate entities, as they often are in China.\textsuperscript{12}

Beyond traditional design practices, integrated design requires the addition and modification of several steps. During the predesign charrette, the developer, owner, architects and engineers should determine sustainability goals and set performance targets. Throughout the design process, energy simulation should identify high-potential energy-saving features and weigh tradeoffs between design decisions. After construction, the design team should commission building systems, educate building operators and monitor building performance.\textsuperscript{13}

Green building design techniques are increasingly relevant to the Chinese market

Green building technologies address environmental parameters such as illumination, ventilation and thermal comfort. Green building design techniques integrate green building technologies to achieve environmentally and commercially sustainable objectives. Design techniques can act as standalone solutions or work in combination with other solutions. CGTI examined four green building design techniques with increasing penetration in international and Chinese markets: green building labeling systems, passive design, Net Zero energy design and intelligent building.

\textsuperscript{12} CGTI analysis
\textsuperscript{13} CGTI interviews and analysis
Green building labeling systems represent the baseline for green building performance. They require buildings to accrue credits across several environmental categories based on performance targets, including energy, water and material savings, outdoor environment, indoor environment, operations and management, and innovation in design. The United States’ LEED and China’s 3-star are the most common labeling systems in China, while the U.K.’s Building Research Establishment Environmental Assessment Method (BREEAM) and Hong Kong’s Building Environmental Assessment Method (HK-Beam) systems have a minor presence. Green building rating systems may differ in credit weightings and modeling tools, and may include unique categories. For example, only LEED includes innovation as separate category, while 3-Star has a separate category for operations and management.

The number of green building certifiers in China is limited, due in part to MOHURD’s reluctance to support third-party assessments. While rating systems have been criticized for reducing the design process into a list of pre-set requirements, these very requirements often indirectly promote integrated design. For example, whole building energy simulation is a prerequisite for LEED during planning, but becomes voluntary in later design stages.

*Passive design* strives to deliver indoor thermal comfort while minimizing the use of electrical and mechanical systems. Passive design incorporates building orientation, window placement and shading technologies to manipulate natural light penetration and solar gain. Tight insulation, heat exchangers, and energy-efficient equipment, which prevent heat waste, are methods to maintain thermal comfort with less mechanical intervention. Due to the dependence on structural features, passive design can be difficult to implement in building retrofits and when optimizing solar positioning. While MOHURD is currently developing a domestic passive design standard, China lacks industry experts, and high upfront costs have prevented widespread investment.

*Net Zero energy design*, a technique gaining popularity in the U.S., uses building integrated renewable energy (BIRE) to reduce net building energy consumption and carbon emissions to zero. Design techniques can include solar water heaters, photovoltaic solar panels, wind turbines and biogas digesters. Net Zero requires sophisticated energy management software and control systems, as well as considerable technical expertise during construction. In locations with feed-in tariffs, excess energy can be fed back onto the electrical grid for a premium price. Net Zero can complement passive design to create cost-effective green buildings by minimizing the use of electrical and mechanical equipment.

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Highly energy-efficient appliances and insulating building components, however, can reduce the need to invest in costly Net Zero energy systems.\textsuperscript{16}

\textit{Intelligent building} relies on advanced communication technology to optimize occupant comfort, manage resources and conserve energy. Also known as building automation systems (BAS), intelligent building employs sophisticated software and control networks to manage building systems. Intelligent building is easy to use, time-saving, energy-efficient and comfortable for users, but buyers incur higher upfront equipment costs.\textsuperscript{17} Two types dominate the market: time-based and parameter-based. Time-based systems operate on pre-established schedules, while parameter-based systems are more complex, and employ occupant sensors and individual controls for task-tuning. Common applications for building intelligence include fire, security, lighting, ventilation, and heating and cooling management.

\textbf{Common design challenges impede widespread market adoption}

Stakeholders must overcome a number of design challenges to accelerate the adoption of green building design\textsuperscript{18}, including:

\begin{itemize}
  \item Building design can have simulation gaps: Conventional design practices do not use energy simulation models, and design changes can be made without assessing their effects on environmental performance.
  \item Energy models are questionable: Building owners, developers and chief architects have disproportionate power in project decision-making, amplifying the risk of model tampering.
  \item LDIs impede integrated design: Officially, only LDIs are qualified to design buildings, while foreign companies operate in a consulting capacity. Additionally, architecture, design and engineering disciples are separate within most LDIs.
  \item Design professionals lack expertise: Architects and engineers typically lack multi-disciplinary experience and expertise. Most Chinese architects specialize in structural engineering.
  \item Monitoring is virtually nonexistent: Green buildings are rarely monitored after construction and few have been operational for five years or more, limiting access to building performance data.
  \item Green building materials are difficult to source: Green building materials are often not available in China. Many products are prohibitively expensive and most must be imported.
\end{itemize}

\textsuperscript{18} CGTI interviews
Green Building Design Success Stories

Recent green building projects underscore implementation challenges and illustrate creative solutions.

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Source: Project information

HSBC’s data center hints at the enormous market potential for existing buildings

In 2009, HSBC’s Data Center in Guangzhou, a modest commercial property of 12,000 square meters, was one of China’s first building retrofits in China to achieve LEED Gold rating certification. Johnson Controls Inc. (JCI), the engineering consultants on the project, improved energy efficiency by upgrading older mechanical and electrical equipment to improve energy efficiency. JCI also installed a building intelligence system to manage energy efficiency improvements and optimize energy use. National and municipal incentives were bundled to recover upfront costs to achieve a competitive payback period. As a result, the project boasts 37% energy savings and a payback period of 2.7 years. For verification purposes, JCI plans to establish a database and share monitoring results after three years of operation.

Reduction in operational costs was the primary objective of the project, while obtaining environmental certification was secondary. Since HSBC is currently rebranding itself as a sustainable company, brand recognition was a major motivating factor. Beyond energy efficiency, the project emphasized sustainable building management. For example, 70% of cleaning supplies and equipment met sustainable green cleaning policies. Employee education on environmentally-friendly behavior was also essential to achieving targets.¹⁹

Shui On Land’s community development offers lessons on incremental improvements

The Knowledge and Innovation Community (KIC) is a 530,000 square meter community in Shanghai by Shui On Land, Ltd. Targeting completion in 2013, the mixed-used development will include Class A office, retail, hotel, residential and research spaces. KIC employs passive design and building intelligence features to reach environmental objectives, already achieving LEED Gold and Silver pre-certification for

some of its office spaces. Passive design features include low emissivity windows, natural ventilation and solar shading. Building intelligence features include energy management controls, smart lighting and intelligent elevators.

Shui On Land has adopted an incremental approach to implementing KIC’s green building. The LEED Silver property saves an additional 36% of energy and 30% of water compared to MOHURD code-compliant buildings; the LEED Gold property boosts 67% and 30% in energy and water savings. KIC is applying for municipal subsidies that should cover 10% of additional investment for green building features.

Solutions from KIC provide useful information about cost-savings: Intelligent elevators require RMB 260,000 in additional investment, but save 40-50% in energy consumption, equivalent to approximately RMB 230,000 per year. Rainwater collection costs RMB 860 million and saves 6,000 metric tons of water annually, or RMB 21,000 per year. These features reflect payback periods between one and 40 years, illustrating the broad range of green building costs. Payback, however, is only one indication of financial performance. For example, the upfront investment in intelligent elevators does not reflect ongoing operation and maintenance costs. Some green building solutions, such as greywater recycling systems, require substantial energy to operate. Despite the challenges, Shui On Land hopes that KIC will serve as a model for green community development.\(^{20}\)

**Vanke City Phase Four highlights the risk of misalignment between design and operations**

Vanke City Phase Four, a 126,000 square meter residential compound in Shenzhen, is one of the few buildings in the country to achieve China’s 3-Star certification after only one year of operation. The compound incorporates passive design features such as aerated concrete, low emissivity windows, adjustable aluminum shading and high window-to-floor-area ratios. Other green building features include solar water heating and rainwater collection. These features save 1.6 GWh of electricity per year, equivalent to a 60% energy savings. Carbon emissions are reduced by 5.3 million tons and sulfur dioxide emissions by 12,200 tons, saving 180,000 tons of water per year.

Company image was the main motivation for the project. Vanke established an internal policy to develop all middle- and high-end residential properties as certified green buildings. However, while 3-Star certification was achieved during the design phase, problems arose after construction. The project incorporated prefabricated materials, but after a year of operation apartment owners tended to make substantial renovations, creating large amounts of building waste. This project highlights the need for

post-construction monitoring to ensure green building design intentions are achieved during operation.\(^{21}\)

**Insights on Green Building Design Themes**

Four themes to further understand optimal green building design in China include design practices, commercial feasibility, design decision-making, and implementation and operation.

**Design practices**

Green building design practices include common systems, features and technologies found in green building design in China. Building professional insights on this topic include:\(^{22}\)

- Technology suppliers must enter the design process early so energy models can explore tradeoffs between competing materials and technologies.
- Owners, architects and LDIs require further education on integrated design processes before these practices can be embraced in China.
- While single suppliers of green building products, such as windows, lighting and HVAC systems are abundant, integrated solutions packages are rare.
- Simple solutions, such as efficient insulation, can have a large impact without the need for sophisticated or integrated technologies.

**Commercial feasibility**

Commercial feasibility of green building design explores tradeoffs between conventional and green building design features. Common metrics include upfront investment, cost premiums and payback periods associated with green building design decisions. Building professional insights include:\(^{23}\)

- Developers consider cost as the most important factor when pursuing projects. While recovering up to 25% of incremental investment for green building solutions through government grants and subsidies may be possible, this may represent a small fraction of total building costs.
- China’s building market is reluctant to embrace green building solutions due to high upfront costs. Initial investments, commissioning, building intelligence systems and monitoring can be prohibitively expensive.

\(^{21}\) China Green Building Evaluation Label, “深圳万科城四期 （设计),” [Shenzhen Vanke Phase Four 3-Star (Design)], http://www.cngb.org.cn, (accessed on Apr. 22, 2011); CGTI analysis

\(^{22}\) CGTI working session

\(^{23}\) Ibid.
• Compulsory building mandates can be effective drivers while China’s green building market matures.
• Although commercial solutions cannot depend on subsidies to be viable in the long-term, incentives for green building technologies can encourage buyers to engage the market, setting economic forces in motion to reduce costs.

Decision-making processes
Green building design decision-making covers stakeholder motivations, incentives and deterrents that influence decision-making in adoption of green building design. Building professionals have noted.24

• Establishing standard metrics would lend transparency to design decisions, allowing decision-makers to quickly identify and weigh green building design benefits and tradeoffs.
• Architects can specify green building materials during the design phase, but contractors may not procure them during construction. Developers are also hesitant to shoulder additional costs for green building products without quality assurance.
• Land is a major cost; developers have been known to pursue green practices simply to acquire land from government programs.

Proper implementation and operation
Proper implementation and operation of green building design features ensures that buildings perform in accordance with design intentions. This entails strategies and best practices for installation, commissioning and operation of green building features. Building professional insights include:25

• Installation is relatively easy to verify for building systems with measurable performance indicators, such as HVAC systems, but discrete building materials are difficult to assess. For example, operational savings from efficient insulation can be difficult to demonstrate, especially over the long-term.
• Property developers show increasing interest in owning the buildings they develop, which may help to align green building incentives. Nevertheless, misaligned incentives remain a major problem: Building operation companies assume control after construction so developers have little incentive to invest in green building technologies that generate operational savings.

24 CGTI working session
25 Ibid.
The Path Ahead

Stakeholders can act to accelerate the adoption of optimal green building design as follows:

• **Designers** can incorporate a multi-disciplinary integrated approach in early design phases. They can help to educate architects, engineers and LDIs on integrated design practices, and work with green building technology suppliers to offer integrated green building solutions.

• **Developers and Owners** wield substantial influence over the market. Large domestic and foreign developers can use in-house expertise and purchasing power to adopt integrated design in green building projects. Developers can establish relationships with building operators, develop monitoring systems for building performance, and share results with designers, architects and stakeholders. Foreign professional service firms can bring integration expertise to the Chinese market.

• **Green Building Technology Suppliers** can form new models of multi-party collaboration across the value chain to package green building solutions and mitigate environmental impacts. They can work together to develop industry standards such as energy simulation metrics and share information to increase the transparency of green building technology performance.

• **Regulators** can issue supportive policies, provide targeted incentives for integrated green building design and increase capacity for policy enforcement.

Tremendous growth in the buildings market, mounting environmental strains and the government’s vision for a sustainable China all signal unprecedented opportunities for green buildings. Integrated design can provide building stakeholders the means to balance commercial and environmental interests, yet challenges persist. Close coordination among design professionals, robust energy simulation and monitoring after construction are just a few design practices the market must embrace to ensure green buildings fulfill their potential. While current design practices leave much to be desired, case studies illustrate nuances that can cultivate successful green building projects today. Bundling incentives to reduce capital outlays, adopting an incremental approach for green building implementation, and establishing safeguards to align design with operation are a few important lessons.
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<td><strong>ACEEE</strong>: American Council for an Energy-Efficient Economy</td>
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<td><strong>BAS</strong>: Building Automation Systems</td>
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<td><strong>BIRE</strong>: Building Integrated Renewable Energy</td>
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<td><strong>BREEAM</strong>: Building Research Establishment Environmental Assessment Method</td>
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<td><strong>CGTI</strong>: China Greentech Initiative</td>
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<td><strong>GWh</strong>: Gigawatt hour</td>
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<td><strong>HK-BEAM</strong>: Hong Kong-Building Environmental Assessment Method</td>
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<td><strong>HVAC</strong>: Heating, Ventilation and Air-Conditioning</td>
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<td><strong>JCI</strong>: Johnson Controls Inc.</td>
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<td><strong>KIC</strong>: Knowledge and Innovation Community</td>
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<td><strong>LEED</strong>: Leadership in Energy and Environmental Design</td>
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<td><strong>LDI</strong>: Local Design Institute</td>
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<td><strong>MOHURD</strong>: Ministry of Housing and Urban-Rural Development</td>
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<td><strong>SOE</strong>: State-Owned Enterprise</td>
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