Sustainability Assessment in a Global Market

Although there are many ways to measure the environmental effects of a building, they are all related to estimates of their life cycle impacts on the environment.

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THE ENVIRONMENTAL IMPACT of buildings on the global environment generally falls under the rubric of "greenness" or "sustainability." In the 1980s, the Brundtland commission defined sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition became part of a global movement towards environmental stewardship, and it did not take long for the building industry to develop a green agenda for the built environment. During the 1990s, so-called green building was quantified according to normalized measures using a rating method that produced a numerical score.

Different countries developed different rating methods, producing an uncoordinated diversity of homegrown rating systems. This paper discusses the main rating systems, their inherent strengths and weaknesses, and recent attempts to develop new, global methods.

FOUNDATIONS

The last 10 years have witnessed a strong surge in the development of building environmental assessment (BEA) systems. The foundation of all BEA methods is life-cycle assessment (LCA), although most BEA systems are more comprehensive than LCA, which is limited to ecological impact assessment. LCA has a foundation in the environmental sciences and is regulated through standards, in particular the ISO 14000 series. A true LCA would incorporate a cradle-to-grave assessment of all of the environmental and social effects produced by a building. In practice these effects are limited to the environmental impact of technologies and products over their full life cycle. A thorough LCA would measure all the impacts, including raw material harvesting, production, manufacturing, distribution, use, and disposal, including the transportation required or caused by the product's existence and use. However, current BEA systems do not use a true LCA because of the complexity of the calculations and lack of appropriate data. For this reason, BEA systems rely on category indicators and weighted ratings, typified by such well-known scoring methods as LEED.

The secondary aim of any BEA system is to encourage the design of green buildings and stimulate the market for sustainable construction components and materials. A properly managed set of guidelines, supported by an adequate BEA system, is the best instrument for local governments to regulate industries and to improve the sustainability of the built environment. World-wide, many assessment programs have been developed to rate the environmental impact and energy consumption of buildings. The first rating system was created in 1990 in the United Kingdom by the Building Research Establishment. The Environmental Assessment Method, or BREEAM, sparked the development of similar rating systems in Canada, Norway, Singapore and Hong Kong. In 1998 the Leadership in Energy and Environmental Design introduced a Green Building Rating System in the United States, largely based on the BREEAM system and now called LEED. Another variant, GBTool, was developed in Canada by the Green Building Challenge. Over the years many of the rating systems have diversified into specialized ratings that govern new construction, residential housing, health care facilities, and other types of buildings.

Other variants have appeared that take a different approach by focusing, for example, on the integration of sustainable design practices in the design processes, and thus more closely aligning with a true LCA approach. One of the systems that focuses on design process integration is the Green Building Initiative that launched the Green Globes system in 2005. Countries such as Japan (CASBEE), China (G-BAS) and New Zealand have developed their own BEA systems, with methodology that is radically different from the earlier rating systems.

BEA systems are constantly being refined to reflect new research findings. One contentious issue is the interpretation of the final rating score. Ideally, the building score should represent a true outcome of the act of constructing a new building. Obviously this outcome should be related to the building's environmental impact and should be computed for the full life cycle of the project, from inception to demolition and recycling. Unfortunately, there are many impacts of a building project for which no verifiable calculation of the outcome exists. In those cases, many BEA systems have introduced feature-based scores that stand in for true outcomes. These surrogate scores do not represent a measured outcome, but rather they reward a certain feature of the building with a specific score. For example, in the LEED system, a building receives a score based on its proximity to public transportation, the assumption being that this means that more people will use public transportation rather than private cars. While it makes sense to reward buildings that are closer to public transport, the true outcome of having public transportation infrastructure nearby is highly unpredictable, because there are so many other variables to consider: cultural habits, the reliability and cost of public transportation, where the workers in a particular building live, and so on. It is problematic when one combines outcome-based scores and feature-based scores, yet all current BEA systems take a more or less ad hoc approach to this fundamental issue.

Another question is the broad scope of BEA systems, which span a wide range of criteria ranging from occupant issues such as productivity-enhancing lighting conditions, to hard-core environmental impacts such as material depletion, landfills and greenhouse gas production. There are current promising attempts to reduce sustainability to its essentials, i.e. covering only those issues that are the intrinsic part of the "social contract" between society and the building. After all, every new addition to the existing built environment de facto requires society to enter into a long-term contract that entrusts a part of the public space to the building owners.

But the fact remains that the building industry has successfully promoted such a wide definition of sustainability that a "sustainable" building has become synonymous with a "good" building, thereby often subsuming the "high performance building." This has led to unintended consequences: buildings that have a high sustainability score but are in fact poor energy performers. An example of this is a recent study by the New Buildings Institute that shows that there is only a very weak statistical correlation between LEED certification and energy performance. Terms such as "greenwashing" and "point harvesting" refer to techniques used to game a BEA system. The next generation of rating systems should eliminate features-based ratings and make all criteria scores outcome-based, moving towards a stronger methodology based solely on an LCA framework.

There are currently more than forty BEA systems in use around the world (Table I). The six best-known (Table II)—BREEAM (U.K.), CASBEE (Japan), CEPAS (Hong Kong), Green Globes (Canada), LEED (U.S.), and SBTool (International)—are discussed below.

Table I: Rating system sources

Sustainable building rating systems	Source	Developmental basis	Date available to public
Green mark	Building and Construction Authority (BCA) of Singapore	LEED, Green Star, and others (not disclosed)	2005
BREEAM (Building Research Establishment's Environmental Assessment Method)	U.K.	Original	1990
BREEAM Canada	Canada	BREEAM	1996
BREEAM Green Leaf	Canada	BREEAM, Green Leaf	2000
Calabasas LEED	Calabasas, Calif.	LEED	2003
CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	Japan	Original	2002
CEPAS (Comprehensive Environmental Performance Assessment Scheme)	Hong Kong	HK BEAM and existing standards in Hong Kong	2007
Earth Advantage	Oregon	Undisclosed for Earth Advantage; LEED for LEED for homes	pilot test 2005
EkoProfile/Eco-Profile (Okoprofil)	NBI Norway	Ecoprofile + ercb	1999
ESCALE	France	undisclosed	undisclosed
EEWH (Ecology, Energy, Waste and Healthy)	Taiwan	LEED, CASBEE	1999
GBAS	China	GOBAS, GBTool, CASBEE, BREEAM	2006

Sustainable building rating systems	Source	Developmental basis	Date available to public
GBTool	International Standard	original	1998
GB/T 50378-2006	China	undisclosed	2006
GEM (Global Environmental Method) U.K. for Existing Buildings	U.K.	Green Globes Canada, BREEAM	2002
GOBAS (Green Olympic Building Assessment System)	China	GBTool, CASBEE, BREEAM	undisclosed
Green Building Rating System	Korea	BREEAM, LEED, BEPAC	undisclosed
Green Globes Canada	ECD Energy and Environment Canada	BREEAM, Green Leaf	2002
Green Globes U.S.	U.S.	Green Globes Canada, BREEAM, Green Leaf	2005
Green Leaf Eco-Rating System	Canada	BREEAM, Green Leaf	1999
Green Star Australia	Australian GBC	BREEAM, LEED	2003
Green Star New Zealand	New Zealand	Green Star	2007
HK BEAM (Hong Kong Building Environmental Assessment Method)	Hong Kong	BREEAM	1996/1998
HEQ (High Environmental Quality)	International Approach	undisclosed	1996
iDP (Integrated Design Process)	Canada	original	1993
Labs21 Laboratories for the 21st Century	U.S.	LEED	1999
LEED (Leadership in Energy and Environmental Design)	U.S. GBC	original	2000
LEED Canada	Canada	LEED	TBD
LEED India	India	LEED	TBD
LEED Mexico	Mexico	LEED	TBD
MSBG (State of Minnesota Sustainable Building Guidelines)	Minnesota	LEED, Green Building Challenge ’98 (GB Tool), BREEAM	undisclosed
NABERS (National Australian Built Environment Rating System)	Australia	undisclosed	undisclosed
PromisE	Finland	undisclosed	undisclosed
Protocol ITACA		GBTool	undisclosed
SBAT (Sustainable Buildings Assessment Tool)	South Africa	original	TBD
SBTool (formally known as GB Tool)	International Standard	GBTool	1998
Scottsdale’s Green Building Program	Arizona	undisclosed	undisclosed
SPiRiT (Sustainable Project Rating Tool) or SPRT	U.S. Army Corps of Engineers	LEED	Undisclosed
TGBR (TERI’s Green Building Rating System); TERI (The Energy and Resources Institute); TERI–GRIHA (Green Rating for Integrated Habitat Assessment)	TERI India	undisclosed	undisclosed
TQ (Total Quality)	Austria	GBTool	2000
TQ-B (Total Quality Building)	Austria	TQ	2007

Table II: Maturity of main systems in use

	System maturity							
	System age			Number of Buildings		Buildings	Stability of system	
	Initiated	Available for public use	Recent revision	Enrolled	Completed	Age	Upgrade frequency	Modification process
BREEAM	1990	1990	2008	3,177	1,358	75	annually	consensus based
Green Globes	2000	2002	2004	X	X	X	not defined	not defined
CASBEE	2001	2002	2007	23	23	4	every year	reviewed annually
SBTool	1996	1998	2007	138	138	14	five times since 1996	reviewed every two years during SBC
CEPAS	2001	2007	n/a	105	0	0	n/a	none exists currently
LEED	1998	2000	2005	6,880	1,059	132	three to five years	board review and consensus

BREEAM

The Building Research Establishment Environmental Assessment Method, BREEAM, was developed in 1990 in the United Kingdom by BRE Global to improve the environmental performance of office buildings and environmental conditions for their occupants. BREEAM is a voluntary, credit-based certification scheme that evaluates new and existing buildings. Buildings are scored, based on points awarded within eight categories: management, health and well-being, energy, transportation, water use, materials and waste, land use and ecology, and pollution. Points are distributed to criteria within each category. Scores are then weighted according to the designated importance of the category and buildings are given a single rating: Pass (25 percent), Good (40 percent), Very Good (55 percent), or Excellent (70 percent).

BRE's continual reassessment of BREEAM has resulted in a substantial rise in the number of registered and certified buildings since 2004. Specifically, the number of registered office buildings approximately tripled between 2005 and 2006 and then doubled between 2006 and 2007. These are indications of BREEAM's success in providing a credible building rating system.

CASBEE

The Comprehensive Assessment System for Building Environmental Efficiency, CASBEE, is described as a labeling tool based on the environmental performance of buildings. Created in Japan in 2001, it is a nationally authorized rating system engaging the cooperative efforts of the educational, industrial and governmental sectors. CASBEE was developed according to the following principles: award high assessments to superior buildings, thereby enhancing incentives to designers and others; simplicity; applicability to a wide range of buildings; and take into consideration issues and problems peculiar to Japan and Asia. CASBEE is a relatively new system that requires documentation of quantifiable sustainable design achievements that are assessed by trained architects who have passed the CASBEE assessor examination. CASBEE handles all four major phases of the life cycle of a project, including pre-design, new construction, existing buildings and renovations. Each tool is intended for a separate purpose and targeted user, and is designed to accommodate a wide range of buildings such as offices, schools, and apartments.

CASBEE covers the following four assessment fields: energy efficiency; resource efficiency; local environment; and indoor environment. Assessment categories for CASBEE are classified into a building environment efficiency (BEE) numerator, a building environmental quality and performance (Q) numerator, and a reduction of building environmental loadings (L) denominator. Q is further divided into three items for assessment: indoor environment (Q1), quality of services (Q2), and outdoor environment on-site (Q3). Similarly, L is divided into energy (L1), resources percent materials (L2), and off-site environment (L3). Scores are based on the scoring criteria for each item. The BEE value assessment result is expressed as the slope of a graph. The higher the Q value and the lower the L value, the steeper the slope and the more sustainable the building. The assessment results for buildings are graded in order of increasing BEE value: class C (poor), class B-, class B+, class A, and class S (excellent).

CASBEE is comprehensive in its scope, providing detailed results in diverse formats (graphs, charts, numeric and text) that make it easily understood and communicated. The rating sheets provide numeric values, an assessment grade, and a written evaluation and description, as well as detailed and comprehensive histograms and other performance charts, which allow for a comparative and comprehensive analysis of the building. CASBEE is unique in its ability to assess both the negative and the positive factors of a building in a "side-by-side" rational relationship. However, this Japanese rating system remains largely ignored by the international market, since a relatively low number of buildings have been assessed using the tool. To date, only three rating systems have used the system and structure of CASBEE as the basis of their development.

SBTOOL

SBTool is a software version of the Green Building Challenge (GBC) international assessment method, which has been under development since 1996 by the International Initiative for a Sustainable Built Environment (iiSBE). The system is based in Canada and includes teams from more than twenty-five countries. Under the GBC process, national teams participate in the development of the assessment method and test it on case study buildings in their own countries. Teams exchange results at international GBC conferences, which generally take place every other year. The system has been recently updated and is now called SBTool (formerly GBTool), reflecting the inclusion of a range of socio-economic variables. SBTool is a rating framework or toolbox, designed to allow different countries to design their own rating systems. SBTool is designed to include consideration of regional conditions and values, in local languages, while concurrently maintaining a common structure and terminology. These include local climate, material use and construction practices and techniques. The system is therefore a very useful international benchmarking tool, one that provides signals to local industry on the state of performance in the region, while also providing data for international comparisons.

SBTool includes criteria in categories such as site selection, project planning and development; environmental loadings; energy and resource consumption; indoor environmental quality; functionality; long-term performance; and social and economic aspects. Criteria are assessed using scales that are based on local benchmarks of "typical" practices; buildings can score -1 if below typical practice, 0 for minimum acceptable performance, or from +3 to +5, representing good to very high performance. All criteria are scored, thus providing a complete assessment of the building. Both benchmarks of typical practice and weightings of criteria are established by the sponsoring organization to represent national, regional, or local codes, practice, context, conditions, and priorities. SBTool has evolved over time, and has been tested by participating countries, with results presented at a series of international conferences.

Originally an as-designed assessment, SBTool can be applied at various phases of the life cycle of a project, including the pre-design, design, as-built, and operations phases. The tool itself comprises two spreadsheets, one for data entry (to be completed by the project team) and one for establishing weights and benchmarks and completing the assessment (to be completed by a third-party assessor). SBTool is comprehensive in its scope, providing both qualitative and quantitative results that make it more easily understood and communicated. The rating sheets provide numeric values, an assessment grade, and a written evaluation and description, as well as detailed and comprehensive histograms and other performance charts, which allow for a comparative and comprehensive analysis of the project in question. Information about the tool as well as the Excel spreadsheet used in the evaluation is available online to download for free in various languages. To this date, four other rating tools have used the system and structure of SBTool as the basis of their development.

GREEN GLOBES

The Canadian Standards Association established the Green Globes System in 1996. Using BREEAM as a framework, it was originally named BREEAM Canada for Existing Buildings. The 1999 version, BREEAM Green Leaf, included both new and existing building assessments, and distinguished itself as a question-based, self-assessment tool. The 2000 version, Green Globes for Existing Buildings, improved accessibility and usability with the design of an online user interface. In 2000 and 2002, adaptations were made to the BREEAM Green Leaf Design of New Buildings, which resulted in the current version of Green Globes for New Buildings. In 2004, Green Globes for Existing Buildings became BOMA Go Green/Go Green Plus under the Building Owners and Managers Association, a representative of the real estate industry. Currently, all new buildings and major retrofits are assessed by Green Globes Canada, while existing buildings are assessed under BOMA Go Green or Go Green Plus. Green Globes has also been adapted to the United States, with the 2005 release of Green Globes US, developed under the Green Building Initiative.

Green Globes is an online, questionnaire-based assessment/rating system and guide for all building types and sizes that provides usability, an integrated team-involvement methodology, a correlation to the design processes, and an integrated external tool interface. The tool sequence corresponds to typical project phases: project initiation, site analysis, programming, schematic, design development, construction documents, contracting and construction, and commissioning. Questionnaires and guides at each phase provide users with feedback to encourage incorporation of green principles during the design process. Evaluations are based on seven environmental performance criteria: project management, site, energy, water, resources, emissions/effluents/other impacts, and indoor environment. Sub-areas of assessment within the seven criteria are designated questions with point values. Questions are answered with a yes, no, or not applicable (N/A). By including the N/A option, the tool is able to readjust the value of total points upon which the overall score is based.

Certification is completed by a third-party assessor. Qualified assessors are architects or engineers with experience in green building. Core objectives and requirements are outlined in the Assessment Criteria Overview portion of the Rating System and Program Summary document (December 2004 version). The final building documents are reviewed during the construction project stage, and a walk through assessment is made during contracting, construction, and commissioning. Buildings are rated with one (15 percent to 34 percent), two (35 percent to 54 percent), three (55 percent to 69 percent), four (70 percent to 84 percent), or five (85 percent to 100 percent) green globes.

CEPAS

The Comprehensive Environmental Performance Assessment Scheme (CEPAS) was initiated in Hong Kong under the 2001 Government Policy Objectives to create a green building labeling scheme. The Buildings Department commissioned a consultancy study by Ove Arup and Partners Hong Kong Ltd., together with local and overseas experts. In 2007, the tool became publicly available for self-assessment.

The CEPAS framework provides building environmental performance assessment at major building life-cycle stages: pre-design, design, construction, and operation. Labeling and certification is possible at specific stages, but there is no single label or award. The analysis is divided into eight categories: indoor environmental quality, building amenities, resources use, loadings, site amenities, neighborhood amenities, site impacts, and neighborhood impacts. Each category score carries a different weight in the final score calculation. The total number of points determines which label is awarded. However, CEPAS is a generic assessment scheme, allowing variations of requirements for different building types.

Although there is no separate category for sustainability, CEPAS addresses the issue mostly in the building amenities and resource-use categories. CEPAS checks for water protection and conservation in various ways: pollution inhibiting amenities, percentage of building's water that is recycled, and the source of water. It calculates what percentage of the building materials comes from environmentally preferred sources and when various provisions are in place to encourage energy efficiency, such as design consideration and shading devices. CEPAS also assesses the long-term sustainability of the building by looking for optimization of utilities, building management and reusability, pollution, and site location. For example, points are awarded for surveying the climate and designing to protect the ecology and contribute financially to preservation.

CEPAS is comprehensive in its method of assessment, its view of the building, and its method of calculation. The building is analyzed from its provisions and layout to its cultural impact, management and contribution to the local ecology and neighborhood. There are required properties and a weighting system for each category, which engages the specific values and needs of Hong Kong. However, the breadth of CEPAS may be counterproductive to promoting sustainability in design practices. For example, the building's ability to connect its inhabitants to the community constitutes almost 9 percent of a CEPAS score, or 15 points. In fact, it is possible to obtain a bronze certification (28 points) by simply fulfilling the required criteria and fulfilling all of the community/transportation criteria in the neighborhood amenities and site impact categories. CEPAS is currently not widely used or well-known in Hong Kong, and there have yet to be any buildings certified.

LEED

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark in the United States for high-performance, sustainable buildings. LEED evaluates environmental performance over a building's entire life cycle, including design, construction, and operations. LEED is a third-party certification program created and administered by the U.S. Green Building Council (USGBC), a member-driven organization comprised of more than 15,000 group members, 91,000 individual members, and more than 51,000 LEED-accredited professionals.

The first LEED program, also known as LEED Version 1.0, was launched in 1998. After extensive modifications, LEED Version 2.0, now known as LEED for New Construction, was released in March 2000. LEED for New Construction was designed primarily for office buildings but has been applied to other building types including institutional and high-rise residential buildings. LEED has since expanded beyond new construction and now includes rating systems for existing buildings, core percent shell, commercial interiors, and homes. Additionally, LEED for Neighborhood Development is under development and is currently being tested.

LEED is a point-based system where buildings must fulfill certain prerequisites and earn points for satisfying specific sustainable building criteria. Most of the criteria are worth one point with the exception of some that can earn incremental points for each additional level of improvement. For example, within the energy performance criteria, buildings earn one point for 10.5 percent optimization, a second point for 14 percent optimization, a third point for 17 percent, and up to a tenth point for 42 percent optimization. LEED for New Construction requires the completion of seven prerequisites and a total of twenty-six out of sixty-nine possible points for basic certification. The criteria are grouped into six categories each worth a certain number of points: sustainable sites (14 points), water efficiency (5 points), energy and atmosphere (17 points), materials and resources (13 points), indoor environmental quality (15 points), and innovation and design (5 points). The number of points a project earns determines the level of LEED Certification. There are four levels: Certified (26 to 32 points), Silver (33 to 38 points), Gold (39 to 51 points) and Platinum (52 to 69 points).

The USGBC is revamping the current system and addressing some of the methodological issues mentioned above. The new version promises to be a major step towards a more transparent and more outcome-based BEA system. En route towards a sweeping change of the system, USGBC has decided to launch an intermediate version in 2009, called LEED 3.0, in which the credits are weighted according to life-cycle analysis indicators. To achieve this modification, LEED added a shell of impact weights that are associated with the current criteria, leaving the previous system structure unchanged. This implies that the scoring methods and rigidity of the system (not being able to simply add or remove criteria), are unchanged. On the other hand, the new scoring approach has a maximum total of one hundred points, and a more adequate weighting of the major criteria, especially climate change and energy efficiency. For existing buildings the system will put more emphasis on building materials, durability, and embodied energy. A future version will apply new cultural, social, and preservation metrics, although it is yet unknown what form these will take. LEED is still hamstrung by a needlessly complicated evaluation method of energy performance, based on the ASHRAE 90.1 standard, rather than the normative ISO-CEN energy performance standard, which is easier to apply and has a number of distinct advantages.

GBAS

GBAS is a newly developed Chinese system based on GOBAS, which was developed specifically to rate the sustainability of the facilities for the 2008 Beijing Olympics. GBAS is designed to be used for the evaluation of office buildings, houses, hotels, schools, hospitals, and gymnasiums, among other building types. Because GBAS is developed for green buildings in China, the evaluation indexes or contents mentioned in GBAS are kept consistent with Chinese national and local standards and codes. The major characteristics and aims of GBAS are "process control and phase-by-phase evaluation, a Quality-Load classification evaluation and a quantitative rating index system." In order to realize process control rather than a final labeling, the assessment process is divided into four phases: PDP (planning design phase); DDP (detailed design phase); CP (construction phase); and COP (commissioning and operation phase). In each phase, specific items are assessed and specific types of data are provided.

GBAS combines characteristics of GBTools, CASBEE, and BREEAM, while recognizing local Chinese condition: a rapidly developing country with a large population and limited resources and land. The regional differences in climate, geography, natural resources, urban development, rural development, economic development, living standards, and customs are also taken into account. GBAS was completed and issued in June 2006 by Tsinghua University. Since then, more than thirty projects among seven cities in China have been evaluated using GBAS.

QSAS

QSAS is a sustainability code developed for the state of Qatar in 2009 by the TC Chan Center for Building Simulation and Energy Studies at the University of Pennsylvania. QSAS combines several current rating systems and consists of categories, criteria, and measurements that define values to be achieved to lower impact on the environment. Categories are the key aspects that affect overall building sustainability. Criteria specify the intent and are linked to measurements that are performance-driven in most cases, notably with respect to water and energy. These measures, based on the prediction of overall outcomes, have the advantage that they do not reward a particular feature but rather the overall outcome. Where sufficient and validated research is not yet available, the system anticipates that sooner or later performance-based measures will become available. To make the transition seamless, all criteria are measured on a uniformly defined rating scale (-1 to 3) that allows the inclusion of a performance-based measurement for each criterion without affecting the system. The aggregation method is applied to the system from the criteria to category levels, which provides flexibility for modifying an individual component without interfering with the entire system. The system has three components: design, construction, and operation. QSAS is now being considered for adoption.

INTERNATIONAL VS. REGIONAL

The goal of all developed and developing countries—to manage the impact of the built environment—has been translated into numerous home-grown rating systems that reflect local needs and circumstances. With the heightened awareness of sustainability around the world and the need of rapidly developing regions to respond quickly, countries without a BEA system are confronted by a difficult choice. They can adopt one of the well-known methods such as LEED or BREEAM; start from scratch with an upfront commitment to the local customs and values (GBAS); or develop some combination of the two (QSAS).

Some countries are choosing to endorse one of the best-known systems, such as LEED and BREEAM. It is unclear if they realize that such systems are not specific to local circumstances and are not easily modified. It is true that LEED and BREEAM have started to offer regionalized versions. But although the modifications do address some local issues, many more changes will be necessary to make the system fit the local environment. In addition, it is uncertain how much local development is needed to do this effectively. This is partly because these major systems want to maintain their original framework and philosophy and therefore are less agile in their response to regional conditions.

Starting from scratch but borrowing the best-of-breed criteria and measurements from existing systems is therefore a competitive and ultimately more effective approach. This way, countries have complete local control. They adapt as local data shows the need and build a lightweight and locally governed regulatory process around the implementation of the BEA system.

BEA methods need to be adapted to local circumstances in order to provide an effective local regulatory or incentive-based instrument. Stakeholder input and buy-in from local organizations are vital. An appropriate BEA system should include design guidelines that the market can absorb and execute. Local market conditions and dynamics require a careful adaptation in every region so that guidelines do not interfere with the demand and supply side of the building process. Acceleration of the translation of BEA results into design guidelines and programmatic instruments and ultimately into legislation is necessary to meet the needs of the local market, especially in a rapidly developing country. The certification of the use of BEA systems, such as the use of standardized normative assessment procedures, requires that they are transparent and easy to use. A strong similarity between local performance standards and related criteria of BEA systems will enhance transparency for the users.

NEXT STEPS

Over the past fifteen years, the construction industry has mobilized a response to the global sustainability challenge. This has led to many diverse efforts across the globe to develop building environmental assessment systems. Until now, their use is voluntary, which means that it is left up to a building owner to require that a building earns a certain desired score, usually denoted as a desired level of certification. Some local building regulations are already making a certain certification level mandatory. For this purpose, current BEA systems will have to be elevated to mature standards. In the United States, ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) has taken the initiative with the USGBC to launch such a standard. The result, ASHRAE 189, is currently under public review.

In spite of all the attention, it is still hard to convince building owners to require a BEA certification. In the United States for example, only approximately 2,000 existing buildings have a LEED certification. The reason for this small number is the cost associated with the certification process, the availability of accredited professionals, and the extra investment in measures that are necessary to obtain the certification. All three factors are being dealt with by the market. As better tools become available and BEA systems become simpler and better tuned to local methods and expertise, process costs will decrease. More training methods, transparent certification and better support tools will provide the expertise that is needed. More research and case studies are meanwhile needed to identify the investment that is required to achieve a desired certification level.

BEA systems have pushed the building industry toward more responsible practices. The biggest impact is the change in the market attitude toward the issue of sustainability by providing verifiable measures to gauge its practices. A potentially larger impact can be expected from the extensions of the BEA system to cover the retrofits of existing buildings. Given the fact that billions of dollars in President Obama's stimulus package are earmarked for the improvements of existing buildings, the availability of retrofit-specific BEA systems becomes essential.

Although a positive transformation regarding key indicators of sustainability such as energy and water has taken place, the effect on overall sustainability is still questionable. This is because the measurement of some sustainability aspects considered in these systems are not objective and it is therefore difficult to demonstrate the benefit. In addition, the number of certified buildings is too small to have measurable impact on CO2 emissions. However, as certain levels of building sustainability are adopted by local building codes, these factors will become important. BEA systems that are cost effective, agile in their adaptation to changing local needs, and supported by adequate tools and expert networks will have the upper hand in this transition phase.