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Environmental Sustainability, Rating System, Green Building, Built Environment

Green Building Rating Systems: A Comparative Analysis

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ABSTRACT

There are presently numerous rating systems across the world for sustainability in buildings. Each country may follow one or more specific rating systems for their built projects. Although most of the systems have similar environmental concerns, they operate differently, with different stresses on different issues. Some of them may be contextually different, some of them may be strategically different, and some of them may be operationally different. This paper wishes to study various Sustainability Rating Systems and tools comprehensively, in terms of categories and issues, and then prepare observations and analysis. The objective of this paper is to bring myriad of rating systems across the world in one place and compare them for their priorities.

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Introduction

In the recent times, a trend of quantifying, measuring and rewarding the efforts of sustainability have come into practice within the realm of built environment. Innovative design measures are being developed and environmentally responsible and resource efficient construction processes are encouraged at all level. There arose a need to quantify and incentivize demonstrable efforts by certain public bodies which led to the concept of rating systems for sustainability.

There are many authorities, governmental and private bodies engaged in this activity with various interpretations based on the geographical location of the operating authorities. The quantification and evaluation of these efforts has resulted in a form of rating systems. The landscape of rating systems across the world is becoming denser as the awareness increases within the building community as a whole. Developed countries have taken a lead in this effort and the developing countries are not far behind. As the number of such systems increases, it becomes essential to analyze them for innovativeness and effectiveness.

The landscape of rating systems across the world is becoming denser as the awareness increases within the building community as a whole. Developed countries have taken a lead in this effort and the developing countries are not far behind. As the number of such systems increases, it becomes essential to analyze them for innovativeness and effectiveness.

Sustainability rating systems of the developed and developing countries are similar, barring a few contextual and quintessential differences. All of these systems focus on saving energy, water, material resources, land use and ecology. They tend to encourage improvement in the waste reduction, pollution control, environmental quality, and efforts in terms of innovative building designs and practices. This paper tries to study and analyze these efforts in relation to sustainability rating systems and bring various systems practiced in different countries, in a single document. The purpose of bringing several rating systems in a single document is to understand the overall context and methodologies of assessments they use, understand different weightages given to the same parameters and to identify positive points and lacunae of each of those systems.

Background

The research on sustainable buildings began in the 1960s, when the theory of "Arcology" combining "Ecology" and "Architecture" was first proposed by Paolo Soleri (Soleri, 2006). After the energy crisis in the 1970s, energy conservation became a critical factor for sustainable development of the world and reducing energy consumption of buildings has attracted more and more attention. In 1980s, Sick Building Syndrome (SBS) was discovered in new buildings and the IAQ (Indoor Air Quality) of buildings became an important issue for human health. In 1991, integrated design approach that considers energy, climate, material, occupancy and surrounding environment was proposed by Brenda and Robert Vale in their publication *Green Architecture Design for a Sustainable Future* (Vale and Vale, 1996).

During the last couple of decades, a great deal of work has been done by many architects, engineers, builders as well as researchers in the field of Green Buildings, the objective of which is to reduce environmental load, cut down resource consumption and improve energy efficiency throughout a building's whole life cycle (Xia, Zhu, & Lin, 2007). World Green Building Council (WGBC) released a special report during the World Green Building Week in September 2010, giving a comprehensive overview of the situation regarding efforts and outcomes of the green building community across the world. "The need to think global, act local has never been more urgent", said Tony Arnel, Chair, WGBC, in his foreword to the report (WGBC, 2010). He also stated that, currently, buildings use 32% of the world's resources in construction. They are responsible for around 40% of global energy use and generate up to 30% of global Green House Gas [GHG] emissions. At the same time, the United Nations Environment Programme [UNEP] has stated that "no other sector has such a high potential for drastic emission reductions and the Intergovernmental Panel on Climate Change [IPCC] has identified that buildings offer some of the most cost effective and expedient ways to reduce GHG emissions" (WGBC, 2010).

Green building rating systems have been developed in response to the market demand for a credible process of identifying buildings that are truly green and sustainable.

Rating Systems

Green building rating systems have been developed in response to the market demand for a credible process of identifying buildings that are truly green and sustainable. To get all the professionals on the same platform and use the same vocabulary, the green building councils and other such bodies have tried to derive rating systems, which quantify the efforts in areas such as sustainable sites, materials and resources, environmental concerns, water management resources, design inputs, etc., in terms of points. The numbers of points are further grouped into star rating, or categories like, platinum, gold, silver, etc. A green building rating system provides a framework for both, understanding what makes any building green and for evaluating the performance of an individual building against the established criteria. Green building certification rewards buildings that achieve a defined level of performance through public recognition. There are a number of green building rating systems across the globe. Most were originally developed to serve the market in a single country.

Each country may follow one or more specific rating systems for their built projects. Although most of the systems have similar environmental concerns, they operate differently, with different stresses on different issues. Some of them may be contextually different whereas some of them may be strategically different and some of them may be operationally different from others.

Each country may follow one or more specific rating systems for it's built projects. Although most of the systems have similar environmental concerns, they operate

differently, with different stresses on different issues. Some of them may be contextually different whereas some of them may be strategically different and some of them may be operationally different from others.

Research Questions

Important questions that emerged during this research were- How many rating systems exist at this point in time? What are the differences and similarities in each of them in terms of the parameters? I have tried to investigate these using various sources from different countries and from different authorities on this subject.

Methodology of Study

As part of literature survey, a broad range of tools for rating sustainable built environment across the world is explored and listed below, along with the publishing authority. To limit the scope of this paper, they are just listed and not discussed at length. They are grouped together based on the geographic regions as mentioned in the WGBC report. The compilation of all the rating systems is divided into five categories. The first four are based on the geographic location around the world, namely Africa and the Middle East, Americas, Asia-Pacific, and Europe. The fifth category mentions the international efforts and the rating tools.

A. Africa and the Middle East

A.1 Egypt:

01. Green Pyramid Rating System - The Egyptian Green Building Council

A.2 Jordan

02. Edama - Edama

A.3 Lebanon

03. ARZ Building Rating System - Lebanon Green Building Council

A.4 Mauritius

04. National Programme on Sustainable Consumption and Production - Ministry of Environment and National Development Unit

A.5 South Africa

05. South African National Standards 204 – SABS standards division

A.6 United Arab Emirates:

06. Sustainable Buildings Assessment Tool - The Council for Scientific and Industrial Research

07. Estidama Pearl Rating System - Urban Planning Council, Abudhabi

A.8 Qatar:

08. Qatar Sustainability Assessment System – State of Qatar

B. The Americas

B.1 Canada

09. BOMA BEST - Building Owners and Managers Association

10. Green Globes assessment and rating system - Green Globes

11. Green Leaf eco rating system - Audubon International

12. Green Plan - City of Guelph

13. Integrated Design Process (IDP) - National Institute of Building Design

14. Local Climate Change Visioning Project [LCCVP] - Collaborative for Advanced Landscape Planning

15. SCPVancouver - NTCIP standards

16. Sustainable Urban Landscapes - University of British Columbia

B.2 USA

17. Earth Advantage Commercial Buildings/ New Homes/ Community - Earth Advantage Institute

18. Labs21 - US Environmental Protection

Agency, US Department of Energy
19. LEED - United States Green Building Council
20. MSBG - Center for Sustainable Building Research
21. O'Hare ASM - CEAT Airport Safety Management Program at the University of Illinois at Urbana-Champaign
22. PLACE3S - California energy commission
23. PlanSmart NJ - PlanSmart NJ, New Jersey
24. Scottsdale Green Building Program - City of Scottsdale, Arizona
25. SpiRit [Sustainable Project Rating Tool] - US Army corps of engineers
26. Star Community Index – Sustainability Tools for Assessing and Rating Communities, Washington DC
27. Sustainable Sites Initiative - American Society of Landscape Architects
28. Sustainable Systems Integration Model [SSIM] - AECOM

C. Asia-Pacific

C.1 Australia

29. AGIC Sustainability Rating Tool - Australian Green Infrastructure Council
30. AHURI Indicator Suite – Australian Housing and Urban Research Institute
31. Building Sustainability Index (BASIX) - Department of Planning & Environment, NSW
32. BioCity Health Index – The Fifth Estate Pvt. Ltd.
33. Climate Adaptation Tools for Sustainable Settlements [CATSS] – Australian Institute of Landscape Architects
34. Defense Estate Sustainability Assessment Tool [DESAT] – Department of Defence, Australia
35. EnviroDevelopment – EnviroDevelopment, Australia
36. EPRA Sustainability Assessment Tool – Engineers Australia
37. Green Globe Precinct Planning and Design Standard – Green Globe Ltd.
38. Green Star – Green Building Council, Australia
39. HIA Greensmart – Housing Industry Association Limited
40. IMUS [Integrated Model for Urban Sustainability] – Nordic council of ministers, Australia
41. Liveable Neighbourhoods – Western Australian Planning Commission (WAPC)
42. NABERS [National Australian Built Environment Rating System] – NSW Office of Environment and Heritage
43. Precinx – Kinesis, sustainability and strategic urban design consultancy, Sydney, Australia
44. SDS [Sustainable Design Scorecard] – City of Port Philip, Moreland city council
45. STEPS [Sustainable Tools for Environmental Performance Strategy] – Moreland City Council
46. Zero Emission Neighbourhood [ZEN] Precinct – City of Melbourne

C.2 Korea

47. Korean Green Building Certification Criteria – Korea Green Building Certification System (G-SEED)
48. Green Building Rating System (GBRS) – International Council of Research and Innovation in Building and Construction (CIB)
49. Green Building Certification System (GBCS) – Korean green building certification system (K-GBCS)

C.3 New Zealand

50. Green Star NZ – New Zealand Green

Building Council (NZGBC)
51. Homestar - Residential Rating Tool - New Zealand Green Building Council (NZGBC)
52.TUSC [Tool for Urban Sustainability] Neighbourhood Tool - New Zealand Green Building Council (NZGBC)
53. Neighbourhood Sustainability Framework - Beacon Pathway Ltd, NZ

C.4 China

54. GBAS [Green Building Assessment System] - Architecture and Building Research Institute, Ministry of Interior, R.O.C
55. GOBAS [Green Olympic Building Assessment System] - - Architecture and Building Research Institute, Ministry of Interior, R.O.C

C.5 Hong Kong

56. HK BEAM [Hong Kong Building Environmental Assessment Method] – HK BEAM Society

C.6 India

57. GRIHA – The Energy Research Institute (TERI)

C.7 Indonesia

58. Greenship – Green Building Council, Indonesia

C.8 Japan

59. CASBEE - Japan Sustainable Building Consortium (JSBC) and Institute for Building Environment and Energy Conservation (IBEC)

C.9 Malaysia

60. Green Building Index – Malaysia Green Building Confederation

C.10 Singapore

61. CBI [The Singapore Index on Cities' Biodiversity] – National Parks Board, Singapore
62. Programme Landscaping for Urban Projects & High Rises [LUSH] – Urban Redevelopment Authority, Singapore
63. BCA GREEN MARK – Building & Construction Authority, Singapore

D.Europe

64. European Urban Audit [EUA] – European Commission
65. SPARTACUS – Global Building Performance Network

D.1 Austria

66. Ecobuilding - Building Optimisation with TQ Assessment – Hauz De Zukunft

D.2 Czech Republic

67. SBToolCZ - SBToolCZ

D.3 France

68. The Framework for Construction Related Sustainability Indicators [CRISP] – The European Commission
69. High Environmental Quality (HQE) – Cerway, France

D.4 Germany

70. PASSIVHAUS – International Passivhaus Association
71. DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) – German Sustainable Building Council

D.5 Italy

72. Protocol ITACA – HubET

D.6 Norway

73. EkoProfile – Environmental Protection Department, Norway

D.7 Portugal

74. LiderA – LiderA Network, Portugal

D.8 Switzerland

75. Project Sustainability Management - The International Federation of Consulting Engineers, Switzerland
76. MINERGIE – Swiss Federal Office of Energy SFOE

D.9 United Kingdom

77. Adaptation Wizard – UK Cilmate Impacts Program [UKCIP]
78. A Sustainability Poverty and Infrastructure Routine for Evaluation [ASPIRE] – Comm Dev Software with International Finance Corporation
79. BREEAM – Building Research Establishment
80. CEEQUAL - Building Research Establishment
81. Defence Related Environmental Assessment Method [DREAM] – Defence Infrastructure Organization
82. GreenPrint – GreenPrint UK
83. Integrated Resources Modeling [IRM] Tool - Arup
84. Manchester Guide to Development – Manchester City Council
85. National Health Service (NHS) Environmental Assessment Tool (NEAT) - Building Research Establishment
86. SUE-MoT – Engineering and Physical Sciences Research Council
87. Sustainable Project Appraisal Routine [SPeAR] - Arup

D.8 Switzerland

88. United Nations Environment Programme (UNEP) Yearbook – United Nations
89. Green Building Tool [GBTool] – International Framework Committee
90. DPSIR (Driving Forces, Pressures, States, Impacts, Responses) – European Environmental Agency

A preliminary study was done of all the tools, which finds about ninety rating systems at the time, actively functioning across the world. The most accepted systems, at least one from each geographic region, were identified for a detailed study, review and analysis. Altogether, six rating systems were identified as listed below

1.BREEAM (UK)
2.ESTIDAMA (Abu Dhabi)
3.GREEN MARK (Singapore)
4.GREEN STAR (Australia)
5.GRIHA (India)
6.LEED (USA)

Common parameters such as Site, Energy, Water, Materials and Resources, Environmental Quality, Management and Others were identified. All six systems were analyzed based on these parameters. This analysis is presented graphically in terms of tables and charts for better visualization. Positive points and lacunas were derived from the detailed study of each of these systems. Based on the detailed studies, a comparison table is derived and graphically presented in terms of a chart. The chart represents all the six systems, the parameters of comparison and the percentage of weight given in each system for a particular parameter. This gives a comparative matrix across all the systems. Further, a table is made to compare all the six systems on basis of their positive points and

the lacunas. The desired outcome of this paper is to bring a myriad rating systems across the world on one common platform of the globalized one world.

Scope and Limitations:

Majority of the identified tools are "assessment tools" i.e. tools that facilitate the assessment of sustainability aspects of an urban development according to a set of criteria. Many identified tools are considered to be "frameworks" i.e. tools that provide guidance on how to deliver a sustainable community. Some of the identified tools are considered to be "indices" i.e. tools that assess the sustainability aspects of a project and rank it in order of performance. As a whole, the tool, framework, or an index, is known as a rating system.

During the literature survey, it was realized that there is a lot of information available about sustainability and green building. It was consciously decided to limit the survey only to the study of rating systems. Within the rating systems also it was realized that it would not be feasible to study, analyze and discuss all of them during the given timeframe. The rating systems across the world which are active as of the day of writing this paper are considered in this paper. Out of them selected six as mentioned earlier, are studied in detail for further analysis. This is an on-going study and if there is considerable time gap between writing this paper and submission, the information given in this may have changed.

Analysis

Sustainability rating systems are designed to resolve the basic issues of sustainability, such as Land and ecology, Energy efficiency, Materials and resources, Water, Indoor environmental quality, Management and Innovation. The importance of each issue varies depending on the local geographic conditions and availability of resources. The overall intent of each issue remains the same for all the tools, but the methodology changes as the tools evolve.

BREEAM (UK) takes credit of being a pioneer in rating sustainability of a built environment, LEED (USA) has paved a way for the concepts of sustainability to establish acceptance internationally, quantify the efforts and spread an acceptable methodology to reward such efforts. Estidama (Abudhabi) approaches green building design holistically through integrated design approach. Green Star (Australia) is the culmination of all the evident efforts of Australian building industry. Australia, being a region of vast geographical variety and apparently enthusiastic in green building efforts, makes Green Star an evolved system. GRIHA (India) establishes a more thorough approach towards the building process, by dividing it into three distinct sections of site planning, building planning, and operations and maintenance, thus separating the logistical processes. Green Mark (Singapore) was developed as a response to creating a sustainable environment for a small country of Singapore, gives a unique approach to dealing with geographical constraints. All the above tools are analyzed against each other since their methodology is similar to each other, barring minor variations.

CASBEE (Japan) and DGNB (Germany), much later entrants, operate differently from all the other previously developed rating systems by

Category-wise % points	Other	Manage-ment	Mater-ial	Water	Site	Environ-mental Quality	Energy
BREEAM		17.9	14.3	7.1	8.9	25	26.8
ESTIDAMA	1.7	7.2	15.6	23.9	6.7	20.6	24.4
GREENMARK	4.5	-	-	9	26.5	3.9	56.1
GREENSTAR	3.2	11.6	20	7.7	7.1	24.5	25.8
GRIHA	4	10	-	13	20	16	37
LEED	9.1	-	12.7	9.1	23.6	13.6	31.8
AVERAGE POINTS	**3.8**	**7.8**	**10.4**	**11.6**	**15.5**	**17.3**	**33.7**

Table 1: Comparison of percentage weightages for six rating systems across common parameters

providing conceptually a unique approach to sustainable development. Both these systems guide with a different methodological approach, dealing with all the issues of green building comprehensively. CASBEE and DGNB are newest tools and adopt a very different methodology, hence they are not compared with the other tools in the analysis presented. The parameters of comparison as mentioned earlier are the most common parameters across all the systems in consideration. Site, water, energy, materials, environmental quality, management and other are taken as categories of comparison. The percentage weightages accorded to each parameter is derived from the earlier studies and compared for the selected systems against each other, presented in **table 1**. At the end of the table, the average values for each parameter is derived for further reference.

These values are put in a graphical format below for a visual representation and better understanding. Different colours are used

The analysis shows that all the tools place maximum importance on energy related issues. Estidama, especially developed for the gulf countries, where water is equally or in some cases more precious than the oil, gives equal importance to energy and water. In most other tools, Environmental Quality is the second most important after the energy.

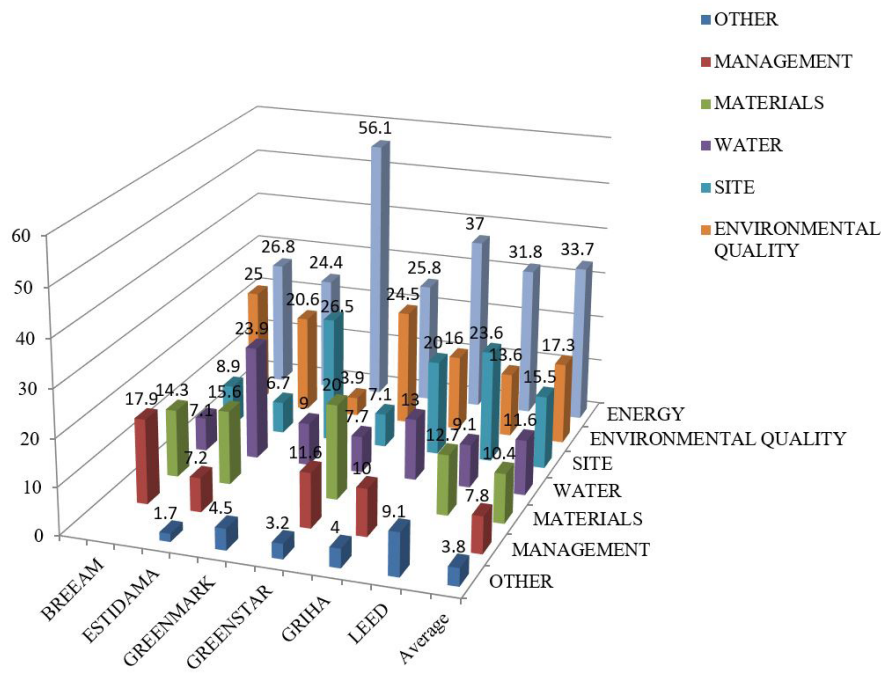

Figure 1: Graphical comparison of percentage weightages for six rating systems across common parameters

for each of the category for easy comparison. Each element is also given a numerical value. A three-dimensional graph is generated for ease of comparison. X-axis represents all the rating systems; the Y-axis represents all the parameters and the Z-axis represents the percentage weightages.

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It would not be accurate to generalize on the basis of average importance given to a particular issue in all the systems, as often they combine two different issues in one category. For example, GREENMARK does not have a separate category such as management, but all the issues are taken care of in the other categories. But this may be a good benchmark to find out commonalities. As we can see there are no major differences, and all the systems are comprehensively dealing with all the important aspects of sustainable development.

	Positive points	Lacunae
BREEAM (UK)	The pioneer of sustainability rating systems, the initiative generated by this system has led to many more positive efforts across the globe. Pollution is made into a separate category and given about 10% of weight, apart from categories like Health & Well-being and Land and Ecology. Specific mention of NOx and Carbon pollution and points given for not engaging in the same is commendable.	Although with noble intentions, too many categories may be baffling. This system was very specifically designed for UK and is not easily adapted by the other countries.
ESTIDAMA (Abu Dhabi)	Integrated Design approach has been categorically rewarded. This system is planned to be integrated within the byelaws and plan is to make it mandatory for every built project to follow this system.	Very specifically designed for arid climate, and difficult to be adapted for other regions. Indoor Environment, Energy and Water have almost equal importance in terms of percentage, which may be proportionally skewed with global perspective.
GREENMARK (Singapore)	Naturally ventilated spaces and use of renewable energy are promoted here. Public transport is highly encouraged. Energy has the largest stake. Energy efficiency is given more than 56% of weight and is followed by Environmental Protection.	No points given for site related issues. All the issues related to materials and environmental qualities are dealt with in this section
GREENSTAR (Australia)	Special mention of efforts to eliminate Legionnaires' disease and use transportation responsibly is commendable. After the five stars for Australian Excellence, a 6 Star category introduced to recognize "World Leadership".	Stress on energy is only 16%, which is lesser compared to any other system which may be skewed in global perspective.
GRIHA (India)	Clear distinction in stages of site planning, construction and maintenance, for easier understanding and implementation of the system. Special care is taken to encourage and evaluate passively cooled and partially air-conditioned spaces suitable to the tropical climate of developing countries.	Specifically designed for tropical climate and some of the parameters may not be feasible to be implemented in other climatic zones.
LEED (USA)	LEED is a very simple rating system. Its simplicity has made it a very popular system across the globe. In fact, many countries are allowed to adapt as it is. This may work as a great way to spread the awareness and build a foundation for the efforts by other countries.	In an effort to simplify the system, some points are made to be too easy to achieve and sometimes may defy the very purpose of the rating system. LEED USA has been adopted by many other Green Building Councils across the world, without making any contextual changes. By following the system which is designed for USA, other countries may not achieve the desired environmental impact, although they may get the rating. Does not leave room in case of inapplicability of criteria.

Table 2: Analysis of rating systems- positive points and lacunae

As mentioned earlier, six rating systems are studied in detail and the positive points and lacunae of the considered rating systems are analysed and presented in **table 2**. These points are considered positive or negative based on the global scenario and not judged for its own merit, since it a known fact that these systems were developed for a particular country in a particular geographic zone.

Identified Lacunae

While going through the literature case studies, some lacunae were observed among the rating systems in general as described below.

- Important issues such as 'quality of living', 'aesthetics of building design', are not addressed while dealing with the issues of sustainability.
- All the systems/ tools lack monitoring for sustained future of the building. Most of them advice monitoring the building performance for one to three years, whereas the average life of a building may be on an average thirty years.
- There is no stress on training the users and persons maintaining the buildings after they are complete.
- There is no incentive for maintaining and monitoring the performance of the building throughout the life of the building.
- The building performance is not regularly evaluated and no encouragement provided for upgrading the performance to the current system of certification.
- There is a major disconnect between designing, building and using a building in a sustainable way, which is not addressed by any of the rating systems.
- None of the systems encourage using renewable energy usage during the building construction.

Conclusion

It is interesting to note that all the rating systems have focused differently on the most common parameters of energy, environmental quality, site specific issues, water, materials and overall management of the project. There are few specific parameters that some systems have used based on their context as mentioned in the detailed discussions. The analysis shows the differences in terms of the positive points and lacunae in each system, which helps us understand the whole scenario better and puts the environmental concerns in overall context which we can relate to and understand better. In terms of creating awareness and encouraging the building professionals to go "green", the revolution has already begun through the several rating systems as described. The governments are offering incentives in terms of taxes, FSI, development charges etc. to the developers, and monetary incentives to the designers and architects. Because of the awareness among the buyers, there are marketing benefits to the builders. The apparent benefits to the end users are in terms of lesser energy bills and pride of being a part of this movement. When all the stakeholders – the owner, architect, developer, builder, consultants, and the end user, as

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well as the environment – are beneficiaries of this movement, it is bound to catch the momentum. Competition between the rating systems and operating authorities is speeding up the process.

The competition among the rating systems and the marketing aspect of the green building may be diluting the required impact of the movement and the momentum it has gathered over the last decade. As a responsible member of the building community, one must adhere to the proven principles of sustainability without being concerned about the rating system or the financial gains in the immediate future. We cannot deny the fact that, the nations need to develop and the buildings have to be built. The only sensible way to make this happen is to take the nature along, think of the environment, and build responsibly. ■

References:

Soleri, P. (2006). *Arcology: The City in the Image of Man*. Arizona: Cosanti Press; 4th edition.

Vale, B. and Vale, R. (1996). *Green architecture design for a sustainable future*. Thames & Hudson Ltd.

WGBC. (2010). Tackling Global Climate Change-meeting local priorities, A WORLD GREEN BUILDING COUNCIL SPECIAL REPORT. http://www.cees.ingersollrand.com/CEES_Documents/WorldGBC_report2010.pdf Retrieved on June 6, 2011.

Xia, C., Zhu, Y., & Lin, B. (2007). *Evaluation of renewable energy system in China's Green building assessment method* (GBAS). (T. U. Department of Building Science, Producer) from www.inive.org: http://www.inive.org/members_area/medias/pdf/Inive%5CIAQVEC2007%5CXia.pdf Retrieved on June 6, 2011.