# *Sustainable Development and Green Building Rating Systems*

*Ar. Asif. R. Khan*
Department of Architecture,
Al Salama Institute of Architecture,
Perinthalmanna, Malappuram, India
ar. asif.k@gmail.com

***Abstract*—Sustainability is, and seeks to establish the values and direction needed to meet the needs of the present without compromising the ability of future generations to meet their own needs. But a sharp deviation from this vision is being observed in the way built environments all over the world have been propping up for last couple of decades. Several building processes and occupant functions consume massive energy and generate large amounts of waste. Thus, buildings are one of the major pollutants that affect urban environment and the universe in total. The impacts of unsustainable design and building practices have a profound impact and in most cases are irreversible.**

**A sustainable building, or green building is an outcome of a design philosophy which focuses on increasing the efficiency of resource use - energy, water, and materials - while reducing building impacts on human health and the environment during the building's lifecycle, through better siting, design, construction, operation, maintenance, and deletion. It is evolved through a design process that requires all concerned – the architect, landscape designer and the HVAC, electrical, plumbing, and energy consultants – to work as a team to address all aspects of building and system planning, design, construction, and operation.**

**A comparative review of the green rating systems formulated by the various energy and resource wings of prominent elite institutions helps to evaluate and generate understanding of the whole process of validation of green buildings. This course of action would also highlight the deficient factors that have gone unnoticed and might help advancement for realization of better built environments.**

***Keywords— sustainability, building process, green rating systems, green buildings, evaluation***

## I. INTRODUCTION

Sustainability, in a broad sense, is the capacity to endure. In ecology, the word describes how biological systems remain diverse and productive over time. For humans it is the potential for long-term maintenance of wellbeing, which in turn depends on the wellbeing of the natural world and the responsible use of natural resources.

The dimensions of sustainability are often taken to be: environmental, social and economic, known as the "three pillars[1]". These can be depicted as three overlapping circles (or ellipses) refer Figure 1, to show that they are not mutually exclusive and can be mutually reinforcing.


Figure 1

While this model initially improved the standing of environmental concerns, it has since been criticized for not adequately showing that societies and economies are fundamentally reliant on the natural world. According to English environmentalist and author Jonathon Porritt, "The economy is, in the first instance, a subsystem of human society ... which is itself, in the second instance, a subsystem of the totality of life on Earth (the biosphere)[2]. And no subsystem can expand beyond the capacity of the total system of which it is a part." The Earth Charter goes beyond defining what sustainability is, and seeks to establish the values and direction needed to achieve it: "We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and to future generations" [3].

Sustainability has become a wide-ranging term that can be applied to almost every facet of life on Earth, from a local to a global scale and over various time periods. Long-lived and healthy wetlands and forests are examples of sustainable biological systems. Invisible chemical cycles redistribute water, oxygen, nitrogen and carbon through the world's living and non-living systems, and have sustained life for millions of years. As the earth's human population has increased, natural ecosystems have declined and changes in the balance of

[1] http://en.wikipedia.org/wiki/Sustainability

[2] http://www.forumforthefuture.org/founder-directors

[3] http://www.earthcharterinaction.org

natural cycles have had a negative impact on both humans and other living systems

## II. UNSUSTAINABLE DEVELOPMENT AND THE BUILT ENVIRONMENT

There is now abundant scientific evidence that humanity is living unsustainably. Returning human use of natural resources to within sustainable limits will require a major collective effort. Since the 1980s, human sustainability has implied the integration of economic, social and environmental spheres to: "meet the needs of the present without compromising the ability of future generations to meet their own needs" [4]. But a sharp deviation from this vision is being observed in the way built environments all over the world


Figure 2

have been propping up for last couple of decades.

We observe that in most cases, it is not our 'needs' relating to the built environment that cause environmental problems- rather it is the way we choose to meet them, refer Figure 2. In routine practice, buildings have major environmental impacts over their entire life cycle. Resources such as ground cover, forests, water, and energy are depleted to construct and operate buildings. Resource-intensive materials provide the building envelope and landscaping supplement it with beauty. Energy-consuming systems for lighting, space conditioning and water heating provide comfort to its occupants. High tech control systems add intelligence to buildings so that they can respond to varying conditions, and intelligently monitor and control resource use, security, and usage of fire systems etc. in the building. Water is another vital resource for the occupants, which gets consumed continuously during building construction and operation. Several building processes and occupant functions generate large amounts of waste. Thus, buildings are one of the major pollutants that affect urban environment and the universe in total. The impacts of unsustainable design and building practices have a profound impact this could be summarized as follows: [5]

- Increased Air Pollution
- Increased Water Pollution.
- Green House Gas Emissions.
- Production of unlimited Waste.
- Effects on Public Health.
- Unnecessary Depletion of Natural Resources.

The anthropometric view of humankind should be altered with significant pace and the fact that "we are part of the universe and not separate from it" should sink deep into the sub consciousness of all.

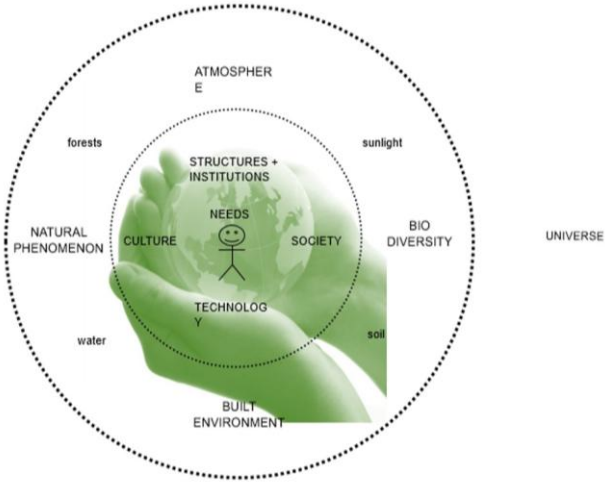


Figure 3

The progression and linkages between critical components like Culture – Society, Institution + Structures – Technology; Built Environment – Atmosphere, Natural Phenomenon – Bio Diversity has to be understood, refer Figure 3. Further this could help to relate to the paradigm shift that is required in understanding the concept of sustainable development and implementation of the same with paramount urgency. It is at this juncture that the epistemological significance of ecological footprint would play a crucial role for the future generations.

Few Basic Truths:

- We need a clean environment for our survival.
- Everything is inter-dependent and inter-related.

In general experiential context the term sustainable building design process or green building approach is played as the trump card to meet the queries raised by environmental protection groups and other related players, who call for a long term relief to the issue of environmental depletion of universe by the built environment.

[4] http://www.unesco.org

[5] http:// www.usgbc.org

The quality of human life has drastically progressed with time and these facilities are required to maintain day to day activities. These cannot be compromised in the name of sustainability. This critical view point acquires great significance in this context. Due to this, drafting and implementation of laws and building rating systems that overlook this aspect don't succeed or get approved by the developed countries. Significant research and related activities

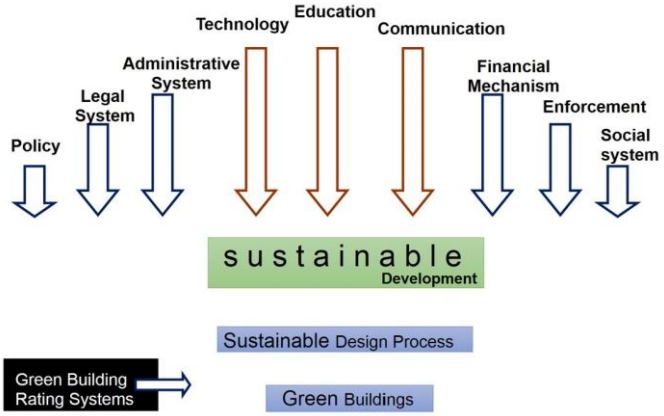


Figure 4

have been undertaken to form the basic criteria of approach to understand the main domains of sustainable development, green buildings and their rating systems worldwide. Most of the focus domains and issues are interrelated. The peripheral parameters which make up the crux of the issue is graphically generated, refer figure 4.

## III. GREEN BUILDING – AN APPRAISAL

A sustainable building, or green building is an outcome of a design philosophy which focuses on increasing the efficiency of resource use - energy, water, and materials - while reducing building impacts on human health and the environment during the building's lifecycle, through better siting, design, construction, operation, maintenance, and deletion. A graphical illustration depicting the basic parameters is shown in figure 5.


Figure 5

It is true that it costs a little more to design and construct a green building[6]. However, it is also a proven fact that it costs less to operate a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in. Thus, the challenge of a green building is to achieve all its benefits at an affordable cost. A green building depletes as little of the natural resources during its construction and operation.

Green Buildings maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. It is evolved through a design process that requires all concerned – the architect and landscape designer and the HVAC, electrical, plumbing, and energy consultants – to work as a team to address all aspects of building and system planning, design, construction, and operation. They critically evaluate the impacts of each design decision on the environment and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment. In sum, the following aspects of the building design are looked into in an integrated way in a green building. : [7]

- Site Planning.
- Building Envelope Design.
- Building System Design HVAC (heating, air conditioning and ventilation).
- Lighting, Electrical, and Water Heating.
- Integration of Renewable Energy Sources to generate energy onsite.
- Water and Waste Management.
- Selection of Ecologically Sustainable Materials (with high recycled content, rapidly renewable resources with low emission potential, etc.).
- Indoor environmental quality (maintains indoor thermal and visual comfort and air quality).

But it is often observed that the thrust to create a visible design solution adhering to the basic criteria listed above becomes the main motto of various builders and green building rating systems validating the same. At times the buildings which are labelled green only tend to observe and practice the green parameters – superficially. A holistic approach which address critical aspects often tend to be overlooked in the whole process of building rating and labelling systems. Therefore its quite important to understand and analyse the existing tools and models available/applied in the built environment to evaluate the so called green buildings.

## IV. COMPARATIVE STUDY

The Energy and Resource wings of prominent elite institutions along with governing/administrative bodies, have

[6] http://en.wikipedia.org/wiki/Green_building

[7] http://www.igbc.in

formulated rating systems to award buildings following a set of laid down criteria and for adopting the motto of "Go Green" as their design philosophy. The rating tools follow stringent parameters while judging these built environments. Comparative studies of few prominent rating systems are generated:

TABLE I. GREEN BUILDING RATING SYSTEM - A COMPARISON

| Rating System and Governing Body | Green Building Design Criteria | Building Types Covered | Certification Process |
|---|---|---|---|
| Leadership in Energy and Environmental Design (LEED INDIA) Green Building Rating System™ Developed by United States Green Building Council (USGBC) | 1. Sustainable site development<br>2. Water savings<br>3. Energy efficiency<br>4. Materials selection<br>5. Indoor environmental quality<br>6. Innovation in Design | Specific LEED rating systems have been developed for most building typologies. | USGBC conducts third party verification prior to awarding a certification. |
| Green Rating for Integral Habitat Assessemt (GRIHA) Developed by The Energy and Resources Institute | 1. Sustainable site development<br>2. Water savings<br>3. Design performance<br>4. Materials and Resources<br>5. Waste Management<br>6. Health and Well Being<br>7. Energy Renewable Practice/Maintenance<br>8. Labor Welfare<br>9. Innovation | GRIHA rating systems have been developed for: Non Commerical, Core and Shell | GRIHA appointed panel of experts. |
| ENERGY STAR Buildings that earn the ENERGY STAR are the top performers for energy efficiency nationwide and use about 35 percent less energy than average buildings. | 1. Energy efficiency | Specific Energy Star rating systems have been developed for most building typologies | A Professional Engineer must verify the Statement of Energy Performance for verification to obtain ENERGY STAR rating above 75. |

### *A. Leadership in Energy and Enviornmental Design (LEED)*

The CII is the central pillar of the Indian Green Building Council or IGBC. The IGBC has licensed the LEED Green Building Standard from the U.S. Green Building Council and currently is responsible for certifying LEED-New Construction and LEED-Core and Shell buildings in India. All other projects are certified through the U.S. Green Building Council. There are many energy efficient buildings in India, situated in a variety of climatic zones. One of these is ITC Green Centre, Gurgaon – certified Platinum level. [8]

TABLE II. DETAIL BREAK UP OF LEED INDIA RATING SYSTEM

| INDEX | RATING | NC | C&S |
|---|---|---|---|
| 1 | LEED Certified | 26 – 32 | 23 – 27 |
| 2 | LEED Certified Silver Level | 33 – 38 | 28 – 33 |
| 3 | LEED Certified Gold Level | 39 – 51 | 34 – 44 |
| 4 | LEED Certified Platinum Level | 52 – 69 | 45 – 61 |
| **INDEX** | **CREDITS** | **NC** | **C&S** |
| 1 | Sustainable Sites | 13 | 14 |
| 2 | Water Efficiency | 6 | 6 |
| 3 | Energy & Atmosphere | 17 | 14 |
| 4 | Materials & Resources | 13 | 11 |
| 5 | Indoor Environmental Quality | 15 | 11 |
| 6 | Innovation & Accredited Professional Points | 5 | 5 |
| | TOTAL | 69 | 61 |

### *B. Green Rating for Integrated Habitat Assessment (GRIHA)*

The Energy and Resources Institute came up with a rating system called GRIHA (Green Rating for Integrated Habitat Assessment)[9] which was adopted by the Govt. of India as the National Green Building Rating System for the country. GRIHA aims at ensuring that all kinds of buildings become green buildings. The strengths of GRIHA lie in the fact that it rates even non-air conditioned buildings as green and puts great emphasis on local and traditional construction knowledge. The CESE building in IIT Kanpur became the first GRIHA rated building in the country and it scored 5 stars, highest in GRIHA under the system. It has become a model for green buildings in the country. It has proved that with little extra investment, tremendous energy and water savings are possible. There are various projects which are the first of their kinds to attempt for green building ratings like apartment residential buildings and non-air conditioned buildings. Measures are being taken to spread awareness about the GRIHA-National Green Building Rating System of India.

TABLE III. DETAIL BREAK UP OF GRIHA RATING SYSTEM

| INDEX | RATING | POINTS |
|---|---|---|
| 1 | One Star | 50 – 60 |
| 2 | Two Star | 61 – 70 |
| 3 | Three Star | 71 – 80 |
| 4 | Four Star | 81 – 90 |
| 5 | Five Star | 91 – 100 |
| **INDEX** | **CREDITS** | **NC** |

[8] http://www.thehindubusinessline.com

[9] http://www.teriin.org/griha/

| INDEX | RATING | POINTS |
|---|---|---|
| 1 | Sustainable Sites | 22 |
| 2 | Water Management/Efficiency | 13 |
| 3 | Design/ Performance | 18 |
| 4 | Materials & Resources | 14 |
| 5 | Waste Management | 8 |
| 6 | Health & Wellbeing | 12 |
| 7 | Energy Renewable Practice/Maintenance | 10 |
| 8 | Labour Welfare | 3 |
| 9 | Innovation | 4 |
| | TOTAL | 104 |

### *C. Energy Star (ES)*

Rating systems are directly based on the energy consumption index of the building. In United States a building is not compared to the other buildings entered into Portfolio Manager to determine the energy star rating. Instead, statistically representative models are used to compare building under evaluation against similar buildings from a national survey conducted by the Department of Energy's Energy Information Administration. This national survey, known as the Commercial Building Energy Consumption Survey (CBECS), is conducted every four years, and gathers data on building characteristics and energy use from thousands of buildings across the United States. Evaluated building's peer group of comparison is those buildings in the CBECS survey that have similar building and operating characteristics. A rating of 50 indicates that the building, from an energy consumption standpoint, performs better than 50% of all similar buildings nationwide, while a rating of 75 indicates that the building performs better than 75% of all similar buildings nationwide. [10]

## V. ENERGY CONSERVATION BUILDING CODE (ECBC)

The Indian Bureau of Energy Efficiency (BEE)[11] had launched the Energy Conservation Building Code (ECBC) on February 2007. The code is set for energy efficiency standards for design and construction with any building of minimum conditioned area of 1000 sqm and a connected demand of power of 500 kw or 600 kva. The energy performance index of the code is set from 90 KWh/sqm/year to 200 kwh/sqm/year where any buildings that fall under the index can be termed as "ECBC Compliant Building". More over the BEE had launched a 5 star rating scheme for office buildings operated only in the day time in 3 climatic zones, composite, hot & dry, warm & humid on 25th February 2009. Reserve Bank of India's (RBI) buildings in Delhi and Bhubaneswar in Orissa has already been rated 4 star and 5 star respectively.

[10] http://www.energystar.gov/

[11] http://www.bee-india.nic.in

## VI. CONCLUSION REMARKS

The way we understand, think and create green buildings are going through extremely fast development of advanced information technologies and digital tools supporting architectural design during the process of generation, representation, simulation and implementation of built environments. In parallel, the user's response to the new orientations on comfort levels and surge for efficiency in post construction scenario has also been elevated. This is the present scenario when we look at the built spaces and their users in total.

Most of the new built environments boast of adhering to the green standards. From the comparative study of the rating systems done, we could summarize that the parameters that contributed towards gaining a significant credit were based on the following three break ups:

- pre-construction stage
    1. Intra and Inter Site Issues
- Building Planning and Construction Stage
    1. Resource Conservation and Reduction in Resource Demand
    2. Resource Utilization Efficiency
    3. Resource Recovery and Reuse
    4. Provision for Occupant Health and Well Being
- Building Operation and Maintenance Stage
    1. Addresses Issues of Operation and Maintenance of Building Systems and Process
    2. Monitoring and Recording of Consumption
    3. Occupant Health and Well Being
    4. Addresses issues that affect Global and Local Environment.

In order to establish supplementary amount of authenticity, more sub criteria were added on to these platforms and detailed rating systems were evolved. The irony is that these models were actually based on existing rating systems that were prevalent in developed countries and therefore certain parameter which could add uniqueness and value when applied for a developing country like India is missing.

The parameters which could be kept in mind while updating the existing systems or for the development of a new holistic rating systems could be as follows:

- India, being a developing country, more than eighty percent of the existing and proposed built up environment is based on semi urban/rural areas. These areas make use of locally available resources and materials and employs intermediate level planning, design and construction techniques. A lack of awareness of new technical

know-how plays a significant role in these areas. Hence, these aspects should be taken into account for fixing the criteria of planning/ design/ implementation/ maintenance stage. The existing parameters which rate modern buildings cannot be used to evaluate or guide the proposed built environments to practice and propagate the Green Rating Systems.

- Finite resources must be more than superficially treated to gain credits. Certain basic procedures which truly portray the authenticity and credibility of the practices followed should be highlighted.
- Another critical issue in general is the lack of proper rating tools to reflect separately on the buildings that are erected in the diverse climatic zones of the Indian Sub-Continent (Hot and Dry Climate, Warm and Humid Climate, Composite Climate, Temperate Climate and Cold Climate)
- Materials and Resources should be given more predilection in such a manner that locally available and environmentally friendly means and methods are applied for the production, procurement and installation. In doing so ardent measures should be followed so that resources are not dilapidated without proper thought and to meet unnecessary man made requirements.
- India has a rich database of vernacular architecture – planning/ design/ construction, which is widely reflected throughout the vast and diverse extend of our country. These traditional built environment were environmental friendly and energy efficient. Modern innovative planning/ design/ construction techniques must be evolved on the basis of these systems which even to date are quite continuing landmarks. Such innovations should form the critical core of evaluation.
- National Level Survey related to Building Energy Consumption should be conducted at stipulated time interval and data gathered based on building typology and energy use from existing buildings across India. This would definitely provide a platform for proper understanding of energy resource consumption. These type of activities would further pave way for better solutions and criteria's for rating.
- Labour welfare should be given prime importance so as to elevate the quality of life of the working class who are instrumental in erecting the infrastructure, irrespective of the scale of construction.


[1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955. (*references*)

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[3] I.S. Jacobs and C.P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G.T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271-350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740-741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.