International Journal of Emerging Technology and Advanced Engineering

Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 316-320

An ISO 9001:2008 certified Int. Journal, ISSN 2250-2459, available online at www.ijetae.com

AN ASSESSMENT OF LEED BASED GREEN BUILDING CERTIFICATION SYSTEM FROM THE ENERGY EFFICIENT BUILDING PERSPECTIVE

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ABSTRACT

Green buildings are heralded as the flagships of sustainable development and they balance long term economic, social and environmental impacts on nature. Innately they are planned to be energy efficient buildings as optimized energy usage is a core aspect of sustainable development. Green building practices should substantially reduce or eliminate negative environmental impacts and improve existing unsustainable design, construction and operational practices. In order to make the green building practices easier to implement, there are technical services and resources for determining the "Greenness" of a building based on an appropriate green rating system suited to the context. The most prevalent system of green rating practiced world over is LEED and the paper attempts to critically review the green prescriptions for scoring under the 6 components for their energy efficiency dimensions using a point based system. This was analyzed using an expert interaction system in a structured fashion. It discusses the prescription wise and component wise virtues and vices of the LEED system as well. The inputs from the experts are collected, collated and compiled and the results are tabulated and discussed. This study concludes that mere adopting methods to attain more points in LEED certification in most cases may not result in holistic reduction in energy consumption but can help to. However, as a system that began to create the awareness in this direction the attempts needs to be rewarded and appreciated.

Keywords: Green buildings, Leadership in Energy and Environmental Design (LEED), Energy Consumption, Sustainability.

1. INTRODUCTION

Green buildings are projected as the flagships of sustainable development due to its underlying responsibility for balancing long term economic, social and environmental impacts on nature. Hence Green building practices should substantially reduce or eliminate negative environmental impacts and improve existing unsustainable design, construction and operational practices. Green buildings are said to be sensitive to the environment, the resource and energy consumption are more justified and they have a profound influence on people, their performance and quality of life with minimal adverse impacts. They also take broader environmental issues such as ground water recharge, global warming etc into consideration.

Reduced operational costs, enhanced building marketability and increased worker productivity resulted from better indoor air quality are the added bonus attached to green buildings. Technical services and resources for determining the *"Greenness"* of a building based on an appropriate green rating system suited to the context are there to make the green building practices easier to implement. This paper at its core attempts to overview the different rating systems in practice to certify the environmental friendliness of the buildings, with a main thrust on Leadership in Energy and Environmental Design (LEED) as it is more prevalent one. Further, the energy consumption of the identified LEED subsystems was analyzed through Delphi Process. The inputs from the experts are collected, collated and compiled and the results are tabulated and discussed.

Presented at International Conference on Energy Resources and Technologies for Sustainable Development, 07-09 February 2013, Howrah, India.

ISSN 2250-2459, *Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, pages 316-320*

2. GREEN BUILDING RATING SYSTEMS IN PRACTICE

Technical services and resources for determining the *"Greenness"* of a building based on an appropriate green rating system suited to the context are there to make the green building practices easier to implement.[1] Three major green design building rating systems provide the basis for the various green building rating systems and certification programs used throughout the world. They are listed below.

2.1 Building Research Establishment Environmental Assessment Method (BREEAM)

It is the first environmental green certification system which was introduced in UK. It has evolved from a design checklist to a comprehensive assessment tool to be used in various stages of building life cycle. Different variations of BREEAM are adopted by several European countries incorporating local environmental requirements. [2]

2.2 Green Building Challenge Assessment Framework (GB Tool)

It is a collaborative venture of more than 20 countries for developing a global standard for environmental assessment. It is not a rating system used for certifying buildings but a guide line for developing regionally sensitive rating systems that could be implemented through local green building programs.[2]

2.3 Leadership in Energy and Environmental Design (LEED)

This rating system is developed with a market driven strategy to accelerate the adoption of green building practices in US by United States Green Building Council (USGBC) [3]. Though BREEAM, GB Tool, and LEED differ in terminologies, structure, performance assessment methods, relative importance of the environmental performance and documentation, all of them are rooted on a criteria based structure that can be defined as a system of assigning point values to selected number of parameters on a scale ranging between small and large environmental impact [4].

Another category of assessment methods are referred to as nature based checklists. This includes Malcolm Wells' "Wilderness-based Checklist", the "Net Positive Change" analysis, and the "Tadoseec" checklist. All these methods share the concept that natural systems best provide the services we desire, and we should rate our interventions for their ability to provide those services [5]. LEED is the most prevalent system adopted by many nations for rating the *"Greenness"* of a building by making marginal variations according to the context [6]

3.0 LEED CERTIFICATION CRITERIA IN INDIA

According to India Green Building Council (IGBC) LEED is a voluntary rating program and the goal is to "evaluate environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a 'green building'. LEED certification is a menu based system as the designer has the freedom to choose from a variety of items to implement in the construction (or renovation) of the building to achieve a desired LEED rating.

3.1 Components of LEED India

The formulated menu for getting LEED certification has six major areas with attached credit requirements [7] and they are briefly explained below.

3.1.1 Sustainable sites

This category is designed to focus on the sustainability of building by reducing the impact of the building to the surrounding environment or by encouraging less environmentally damaging modes of transport. The major credit allocations in this category are site selection depending on the nature of site redevelopment, storm water management, reduction of heat island and light pollution and encouraging the use of vehicles with alternate energy and related facilities

3.1.2 Water Efficiency

This category is included to encourage more efficient use of water and waste water treatment. Use of high efficiency irrigation technology, rain water harvesting, and the use of high efficiency plumbing fixtures fetch some credits in this category.

3.1.3 Energy and Atmosphere

Energy efficiency, utilization of renewable energy and ozone protection are the main goals of this category of credits. The credits can be earned depending upon the percentage of energy saving in the building by means of alternative energy usage. More credits are allocated for the implementation of on-site renewable energy technologies depends upon its percentage provided towards the total energy consumption. This also encourages the non-use of HCFC's and use of Green power.

3.1.4 Materials and Resources

This category is aimed at reducing the life cycle environmental impact of building materials. Credits awarded in this category are for reusing an already existing building shell, recycling of construction waste, use of recycled materials and for the use of local or regional materials.

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3.1.5 Indoor Air Quality

Reduced indoor pollution, improved thermal comfort, indoor air and lighting quality are the major goals of this category. The use of low emitting adhesives, sealants, paints, carpets and use of composite wood will fetch some credits. More credits can be earned by installing a permanent CO_2 monitoring system, individual occupant controls, increased ventilation level, improved day lighting etc.

3.1.6 Innovation and Design Process

This category encourages incorporating innovative design features not addressed by LEED and also incorporating LEED accredited professional in the design team. No standards are set to claim the credits in this category

4. LEED CERTIFICATION SUBSYSTEMS

4.1 Identification of LEED Subsystems

In analyzing the LEED certification system or the credit allocation in the LEED certification [8], we are considering only those credits or a subsystem, which has some direct relevance in the context of energy consumption parameters. The sub systems so identified are Sustainable sites, Water Efficiency, Energy & Atmosphere, Material & resources and Indoor Environmental Quality. Within these subsystems, though there are six to fourteen different heads for credit allocations, only those which have direct relevance to the context of energy consumption parameters are selected for analysis (Table 1).

Table 1 Identified LEED subsystems

No	LEED credit allocation systems	LEED credit allocation subsystems
1	Sustainable Sites	Site selection Community Connectivity Alternate Transport Storm water design Heat island effect
2	Water efficiency	Water efficient landscaping Water efficient HVAC Reduced water use
3	Energy & atmosphere	Optimized energy performance Renewable energy Ozone depletion Green power
4	Material & Resources	Building reuse Construction waste management Resource reuse Recycled content Regional materials Certified wood
5	Indoor Environmental quality	Increased ventilation Low emitting materials Indoor chemical & pollutant source control Controllability of systems Thermal comfort Day light

5. ENERGY CONSUMPTION ANALYSIS OF LEED SUBSYSTEMS

Main aim of this paper is to determine a Net Energy Impact Score (NEIS) for the identified LEED Subsystems within the perspective of energy consumption. To obtain NEIS of LEED subsystems an analysis based on an Expert interaction through Delphi process is followed. Focus of the Delphi process was on identifying the environmental impacts due to energy consumption, both positive and negative due to selection of various techniques and methods adopted to earn points under the selected heads of LEED subsystems as discussed above.

Table 2: Energy consumption assessment of LEED rating subsystems

LEED credit allocation systems & its subsystems		Energy Consumption (ECS)	LEED point Allocation	Energy Impact Score (EIS)
Sustainable Sites	Site Selection	2	1	2
	Community Connectivity	3	1	3
	Alternate Transport	2	3	6
	Reduced site disturbance	0	2	0
	Storm water Design	1	2	2
	Heat Island Effect	3	1	3
Net Energy Impact Score(NEIS)				**16**
Water Efficiency	Water efficient landscaping	1	2	2
	Water efficient HVAC	-1	1	-1
	Waste water treatment	-1	1	-1
	Reduced water use	1	2	2
Net Energy Impact Score (NEIS)				**2**
Energy & Atmosphere	Optimized Energy Performance	3	8	24
	Renewable Energy	3	1	3
	Ozone Depletion	2	1	2
	Green Power	3	1	3
Net Energy Impact Score (NEIS)				**32**
Material & Resources	Building Reuse	1	3	3
	Construction Waste Management	-2	2	-4
	Resource reuse	2	2	4
	Recycled content	-1	2	-2
	Regional Materials	2	2	4
	Certified Wood	-2	1	-2
Net Energy Impact Score (NEIS)				**3**
Indoor Environmental Quality	Increased Ventilation	2	1	2
	Low Emitting Materials	1	3	3
	Indoor Chemical & Pollutant Source Control	-1	1	-1
	Controllability of Systems	2	1	2
	Thermal Comfort	-3	1	-3
	Day light	2	2	4
Net Energy Impact Score (NEIS)				**7**

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While assuming the influence of the LEED subsystems on energy consumption, only Indian context were considered and to that level this evaluation may be treated as location specific in nature. Some of the relevant components of the LEED subsystems were bundled together and considered during the expert interaction session and the points reflect the combined effect of it on energy consumption. The analysis process was planned to capture the positive and negative environmental impacts of the identified LEED subcategories from the perspective of energy consumption. A group of experts comprising of Environmentalists, Green building experts, Architects and engineers were together brainstormed in a structured fashion and rated the interaction against energy consumption on a ten point scale. In order to avoid the bias of individual experts, a minimum of 5 experts are included in each category. In the rating scale, +5 denote high positive influence, +3 denote moderate positive influence, +1 denote minimal positive influence, 0 denote no influence, -1 denote minimal negative influence, -3 denotes moderate negative influence and -5 denotes high negative influence. This score is called Energy Consumption Score (ECS) and are recorded in Table 2. From this an Energy Impact Score (EIS) for the respective subsystems are calculated by multiplying it with the LEED points allotted to each subsystems. A Net Energy impact Score (NEIS) for each LEED subsystems are deducted from EIS.

6. DISCUSSION OF RESULTS

In general LEED is a rating system, which should advocate energy efficiency in all aspects of the building. [9] It should also make sure that energy consumptions of the various techniques adopted in buildings to gain LEED points are also less in comparison to the conventional techniques. Hence the building with a higher LEED points should be ideally is more sensitive to energy consumption than the one with a lower LEED point rating. The EIS obtained for each category expresses the comparative extent of energy efficiency or lack of it for different sub categories. The Net Impact Score acquired by each subsystem reflects the net impact on the environment both positive and negative when adopting different means and methods to gain LEED points in the respective subsystems. A detailed analysis of this is given below.

While exploring the bearing of LEED certification system on energy consumption, it is quite evident that the LEED point allocation is not linearly proportional to the energy consumption pattern of the various techniques adopted to gain these points. In sustainable sites, ECS for different subsystems varies from zero to three and that of LEED point allocation is from 1 to 3. But the contradiction is that an ECS zero has fetched two LEED point while in the case of community connectivity and Heat island effect which has an ECS of three has only one LEED point.

An important aspect to be noted in this case is that the selection of systems to score LEED points in sustainable sites has a positive influence on environment. As same ECS value should ideally reflect the same positive and negative impacts on the environment, logically LEED point allocation should also be same if the same had enough considerations towards the environmental impacts. Subsystems with a high ECS like community connectivity and heat island effect (ECS 3 each) should be having very high LEED point allocation too when compared to the subsystems with zero ECS, which is an apparent conflict in LEED rating from the energy consumption perspective

In case of water efficiency the LEED point allocation is almost proportional. But some negative influence is evident in this case, which reflects in the Net Energy Impact Score of the subsystem. In energy and atmosphere, the ECS of the subsystems are 2 and3, but there is considerable variation in their LEED point allocation. The LEED rating system gives importance to minimal energy usage. Ideally systems used in a building to gain higher points as per LEED rating should be causing more positive benefits than negative impacts. For example optimized energy performance with an ECS of 3 has eight LEED points compared to utilization of renewable energy which is also having the same ECS has only one LEED point. This is same in the case of subsystems like ozone depletion and green power. In the present scenario of energy crisis and climate change, more importance and there by more LEED points should have been given to systems which uses renewable energy.

Material and resource selection has high influence on the environment as the choice of too many energy intensive, emission intensive materials has an adverse influence. ECS values vary between -2 and 2 amongst the various subsystems, but the LEED point allocation is not in line with the secured score. Some subsystems have secured negative ECS due to its high energy consumption compared to the conventional methods, like construction waste management, certified wood etc. But LEED points for these subsystems do not reflect this aspect. It is observed by the experts that there is need for reviewing the credits/points allocated for recycled content of the materials as well. Energy used to recycle the material will be much higher than the energy used to produce the same material form fresh resources [10]. While allocating credits, impacts and side effects of the process of recycling should also be considered.

In Indoor Environmental Quality, ECS of the different categories vary from -3 to +2, but the LEED point allocated is within the range of 1 to 3. Increased ventilation and employing methods that facilitate maximum daylight usage has same ECS, but its LEED point is not the same. LEED point allocation disregards the detrimental impacts created on the environment by the advocated artificial systems which are used to achieve thermal comfort in buildings.

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As the name of the category suggests, importance should be given to the physical comfort consequent to beneficial thermal condition, but it should not be at the cost of increased energy consumption and its related adverse impacts. This category should advocate systems that were used in traditional buildings to achieve better indoor environmental quality. From the above study and analysis of ECS for its compliance with the point allocation of LEED certification criteria, it is quite evident that point allocation is not linearly proportional to the obtained ECS.

Net Energy Impact Score (NEIS) is a measure of the net environmental benefit each category can contribute to the environment when we adopt systems and methods to attain LEED points under these categories. A LEED rated building should ideally be very sensitive to energy consumption aspect. Hence any system adopted/ advocated to achieve LEED point should be carefully chosen to make sure that it will consume only less energy in its various life cycle phases like production, operation, maintenance and de-commissioning. [11] A low NEIS of Water efficiency, Material and Resources and Indoor environmental quality shows that this aspect was not taken into account while suggesting systems as well as in LEED point allocation.

7. CONCLUSION

The study concludes that mere adopting methods to attain more points in LEED certification in most cases may not result in holistic reduction in energy consumption but can help to. However, as a system that began to create the awareness in this direction the attempts needs to be rewarded and appreciated. While formulating Green building certification systems, geographical context and their climatic sensitivities should be given enough consideration than replication of the norms as evolved and practiced elsewhere. This analysis indisputably establishes the relevance of energy consumption analysis of the LEED certification criteria for achieving truly sustainable development. On comparing the ECS corresponding to some of the combined categories of LEED certification criteria and its LEED rating point allocation as existing, it may be concluded that LEED rating point allocation system is not truly aligned to the concept of energy conservation in a holistic sense.

REFERENCES

1. Cole, R.J., 1999, Building environmental assessment methods- clarifying intensions, *Building Research and Information*, Vol. 27 (4/5), 1999, pp. 230-246
2. Cole, R.J., 2003, Building environmental assessment methods- A measure of success, Construction, 26(1), 1-8
3. Gowri, K., 2004, Green Building Rating Systems: an overview. American Society of Heating Refrigeration and Air conditioning Engineers Inc Journal.
4. Hikmat, Ali. Saba, Al Nsairat., 2009, Developing a green building assessment tool for developing countries –Case of Jordan. Building & Environment, 1053-1064.
5. Anil Kumar. PP, Nair, Anjitha B., 2009, An LCA based Evaluation of Core Green Building Principles. Proceedings of International conference on Sustainable Architecture. Trivandrum: Indian Institute of Architects, Trivandrum centre.
6. Smith Timothy. M., 2006, A Comparison o the LEED and Green Globes Systems in the US, The Western Council of Industrial Workers
7. Indian Green Building Council, 2011, LEED India Green Building Rating System, Confederation of Indian Industries, New Delhi
8. Barbera, N., 2006, White paper- Life cycle and the Building and Construction Industry, Beacon Pathway Limited and Foundation for Research Science and Technology
9. Cole, R., 2007, Energy use and Urban buildings, Handbook on urban sustainability, edited by N Munier
10. Scheuer, C. W., 2002, A Report on Evaluation of LEED using Life Cycle Assessment Methods, National Institute of Standards and Technology
11. Chithra. K. PP, Anilkumar, 2010, An Appraisal on the LCA compatibility of the India's LEED rating system for Green building certification, proceedings of International Conference on Urbanism & green Architecture, National Institute of Technology, Hamirpur, India.

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