iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31394

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Comparison of Indigenously developed Green Building Rating System - Outlining the Subtle Distinct Features

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Abstract: The main focus of this study is to outline the subtle distinct features in the "Energy" modules in green building grating systems i.e. Green Rating system for Integrated Habitat Assessment (GRIHA) and Indian Green Building Council (IGBC). For which we will start up with the building model being simulated in an energy simulation software/tool that are certified by competent authorities. The results as obtained from the simulation of the proposed building model will be used. Since, there are different benchmarks for allotting credits for achieving minimum energy efficiency such as Energy Performance Index (EPI) in GRIHA and percentage savings in energy consumption cost in case of IGBC.
Keyword: GRIHA, IGBC, eQuest, Green Building

I. INTRODUCTION

Buildings are key to a sustainable future because their design, construction, operation, and the activities in buildings contribute significantly to high energy consumption – reducing energy demand in buildings can play a pivotal role in reducing energy consumption and solving challenges that lies ahead.

Energy services in buildings – HVAC systems for thermal comfort, refrigeration needs, lighting systems installed, communication and entertainment (such as Television's, Laptop's, other accessories), as well as other amenities are majorly responsible for a significant share of energy use worldwide. Several energy-related problems affecting human health and productivity take place in buildings, due to poor indoor air quality or inadequate indoor temperatures. Hence, this issue must also be addressed to improve occupant's health and increase efficiency of people working inside these buildings.

Reports includes that India's National Development Council is centered around the building sector based on energy conservation, vowing to make its Energy Conservation Building Code (ECBC) stricter, featuring its local building rating system GRIHA (Green Rating for Integrated Habitat Assessment), which is used for scaling the green building and energy efficient projects in the country. With rapid urbanization, as the quality of life improves, more and more people are being lifted above poverty line, and easy access to electricity. EIA projects that electricity's share in the total use of energy in buildings will nearly double in non-OCED countries, from 21% in 2018 to 38% in 2050 as compared to electricity's share of delivered energy consumption in OCED countries buildings will decrease from 24% to 21%.

Kibert [1] through their research portrayed that Green buildings are built on the basis of ecological principles and the effective use of natural without compromising robust facilities. As per WGBC [2], Green building facilitates the preservation of precious natural resources and the improvement in the overall quality of life. The term Green Building can be easily understood in broader sense as the building or facility that consumes less amount of energy as compared to conventional buildings, reduces the dependency on energy supplied by grid, instead employs renewable energy sources, reduce their water demand through water harvesting and other techniques. The principle of "reduce, reuse and recycle" is relevant to green buildings.

Zuo & Zhao [3] concluded that there is a need to evaluate the coverage of social and economic aspects of sustainability in green building rating and support the development of new ratings.

Feng et al [4] Apart from short-term and long-term benefits that green building provides to its occupants, a green building needs to be economically rational.

Analytical Hierarchical Process (AHP) is used to evaluate the relative significance among common components that contribute to sustainable buildings. Many rating systems that were studied were noticed to perform only a part of their originally intended objectives with energy efficiency taking the highest priority [5].

Uger & Leblebici [6] showed that one of the main things to understand is that developers, and investors are most of the times concerned with the economic performance of the green buildings as compared to the conventional buildings. Hence, the cost-benefit analysis of green buildings is widely conducted.

Zhang et al [7] concluded that Energy is important to the certification results and occupies a high proportion of the total scores in green building rating systems. Also Geng et al [8], concluded that no apparent relation is found between the green building certification level and the actual energy use.

In this study two of the most widely practiced green building rating systems in India (GRIHA & IGBC) are compared with each other.

II. METHODOLOGY

A. GRIHA and IGBC

GRIHA stands for Green Rating for Integrated Habitat Assessment. GRIHA is derived from a Sanskrit word meaning – 'Abode'. Buildings and environment interact with each other in various ways. Throughout the life cycle of buildings, from construction to operation and then demolition, they consume resources in the form of energy, water, materials, etc. They emit wastes either directly in the form of municipal wastes or indirectly as emissions. GRIHA attempts to minimize a building's energy consumption, waste generation, and overall ecological impact to within certain nationally acceptable limits / benchmarks [9]. GRIHA is a rating tool specifically developed in India to meet Indian condition that enables people to assess the performance of the buildings against a nationally accepted benchmark. With the rapid urbanization, surge in population an enormous demand erupted to house many employees in buildings.

The Indian Green Building Council (IGBC), portion of the Confederation of Indian Industry (CII) was shaped in the year 2001. IGBC has developed various rating systems to cater to the needs of growing building industry that comprises of different types of facilities and buildings that are intended for different purposes. The different IGBC rating systems are IGBC Green New Buildings, IGBC Green Existing Buildings, IGBC Green Homes, IGBC Green Residential Societies, IGBC Green Affordable Housing, IGBC Green Healthcare, IGBC Green Schools, IGBC Green Resorts, IGBC Green Factory Buildings, etc. With wide variety of rating systems developed specifically for different types of facilities, the aim to effectively implement green practices can be achieved in a more cohesive manner

B. Simulation Tools

To verify whether these systems, qualify for the set level of performance and how do these systems respond to the building behavior in different weather conditions and to the local environment, an exhaustive analysis of building parameters needs to be carried out. With the advancement of the software industry, it has provided us with the plenty of the opportunities in forecasting the energy performance of the buildings.

For the present research, eQuest 65 software was used. The results were interpreted on the basis of investigation carried on eQuest 65.

The following figure 2 shows the simulation model picture of the plan to be studied.

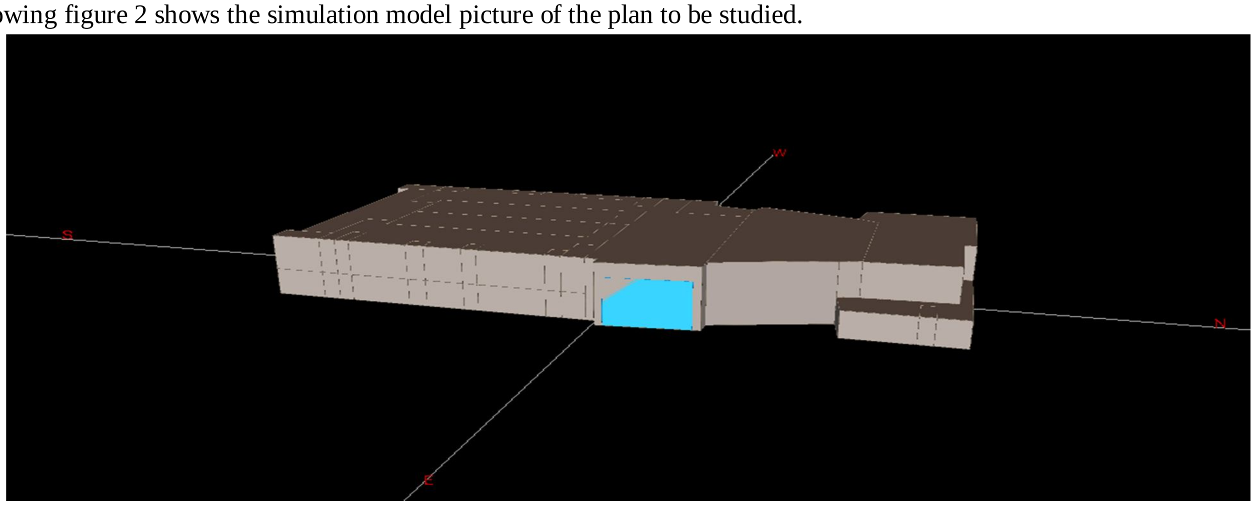

Fig 2. Simulation Model

III.RESULTS AND DISCUSSION

A. IGBC Results

The building compliance path is through ASHRAE Standard 90.1-2010, Appendix - G (without amendments) through Performance based approach (Whole building simulation). The Simulation was carried out to be carried out at comfort temperatures of 24 ± 2 °C. The following table I shows the summarized results of IGBC.

TABLE I: IGBC Results Summarized

Consumption Entity	Value
Annual Consumption of the Proposed Simulation Model as per actual construction (kWh)	445551
Annual Consumption of the Baseline Simulation Model as per ASHRAE 90.1 2010 Appendix-G (kWh)	782658
Miscellaneous Equipment consumption in both the Cases which must be deducted from both the models (kWh)	47606
Percentage Savings	46%
Points allotted as per table of 90.1 2010 and IGBC NB Tables for points against savings in Air-conditioned buildings	15

The building simulation requires that a model of the subject (proposed) building be created, not a physical model but a virtual model with the help of a simulation tool/software. It should be capable of simulating the important thermodynamic parameters of the proposed building. A clear understanding of the operation of the proposed building is essential as it will help improve the overall accuracy of the simulation model. The virtual-proposed model on the software would now behave almost exactly as the real building. In this simulation model, annual consumption is to be evaluated. Hence, the energy consumption calculation hour-by-hour over an entire year is done using the weather data of that location where the subject building is located.

The graph below figure 1 is an output result from the eQUEST 65 software. The unit price is INR 5.25. The dollar ($) value is 70.

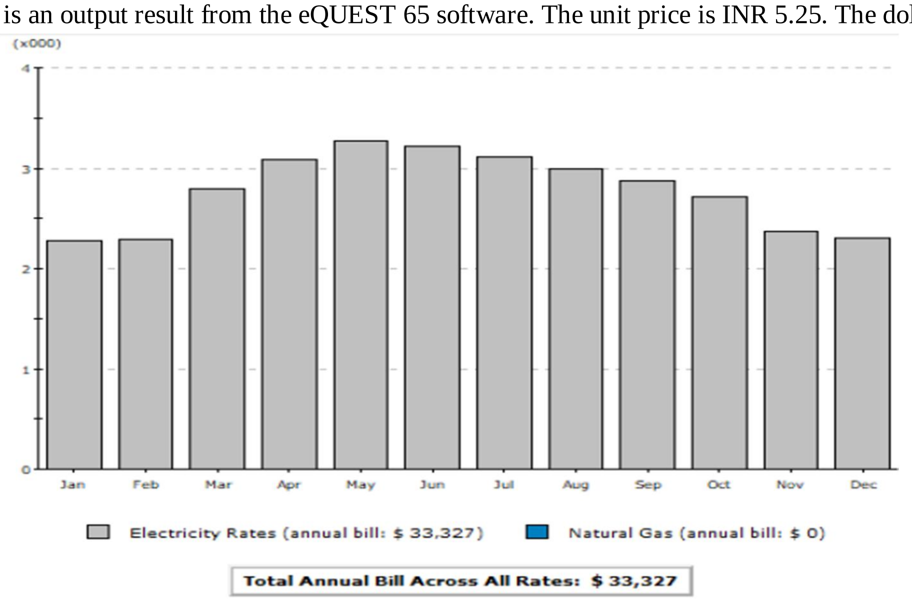

Fig. 2 IGBC Model - Proposed Case Consumption Cost

As can be clearly seen from the results generated from the simulation, the annual cost of consumption of baseline model is more than the proposed model. Hence, the percentage savings are calculated from it. The points are then allotted for the corresponding percentage savings. Since, no natural gas is being utilised in the subject facility, the natural gas consumption is equal to zero. The annual consumption of the subject facility is mainly due to mechanical systems, electrical systems that are installed in the subject facility that runs on electricity. As per IGBC – NB v3.0 Table – Percentage of Energy Cost Savings over ASHRAE Standard 90.1-2010 Base case, considering the percentage savings obtained the points awarded to the subject facility is 15.

B. GRIHA Results

As stated initially, our aim is to ensure that the projects are developed as an energy efficient projects that can be achieved by:

1) Enhancing the building envelope performance.
2) Reducing the annual consumption of the building by installing energy efficient HVAC systems.
3) Installing energy efficient LED lighting systems.

The annual energy consumption is calculated with the help of energy simulation, by simulating the actual energy use as per the plans of the subject building. In GRIHA, our aim is to calculate the EPI (Energy Performance Index) of the building. Energy Performance Index (EPI) of a building is its annual energy consumption in kW-hr per square meter of the building. EPI of a building can be determined by:

EPI = annual energy consumption (kWh)/total built-up area (excluding unconditioned basements)

Hence, as per GRIHA benchmark for EPI for an institutional building that has an 8-hour operation in Composite climate has an EPI of 90. Therefore, the percentage reduction in EPI can be calculated. The percentage reduction in EPI in this scenario is 32%.

The following table II shows the GRIHA results.

TABLE II: GRIHA Results

Consumption Entity	Value
Annual Consumption of the Proposed Simulation Model as per actual construction (kWh)	44555 1
Miscellaneous Equipment consumption which must be deducted from model (kWh)	47606
Area of the Building (In Square Meter)	6530
Energy Performance Index of the Proposed Building	61
GRIHA 2015 Benchmark for Institutional Building having 8-hour operation in Composite Climate	90
Percentage reduction in EPI in Proposed Building due to Energy Efficient Design & Construction	32
Points awarded to the property as per GRIHA Version 2019	4

IV. CONCLUSIONS

The aim of the study was to outline the common denominators and distinct features between the Green Rating Systems that are indigenously developed in India. This study mainly focuses on Energy Related credits. The common denominators between the two rating systems mainly include Mandatory Compliance with Bureau of Energy Efficiency Standard Energy Conservation Building Code (ECBC) 2017 and Availability of multiple compliance Paths i.e., Whole Building Simulation Approach and Prescriptive Method and/or Building Trade-Off Method. Following conclusions were drawn from the research:

A. The foremost distinct feature between IGBC and GRIHA Energy Compliance through Whole Building Simulation Approach is that the Baseline/Benchmark to be followed for GRIHA is based on EPI Calculations for which the Baseline value is a number provided by the GRIHA Council/TERI's empirical results in conjugation with ECBC 2017.
B. For IGBC, the Baseline value reflects Empirical benchmarks set up by ASHRAE/ANSI Standard 90.1 2010 and for path 2, the benchmarks as proposed by the IGBC.
C. The other distinct feature is the percentage of points allotted to the Energy credits in the two Rating Systems. GRIHA has a total of 8 Points allotted to EPI compliance for Energy Optimization where as IGBC allocates 15 points for Energy Efficiency compliance.
D. An inference may be drawn that GRIHA focuses on multiple aspects of building design keeping Energy Performance (Consumption) at a lower percentage than IGBC but diversifying the scope of overall rating.

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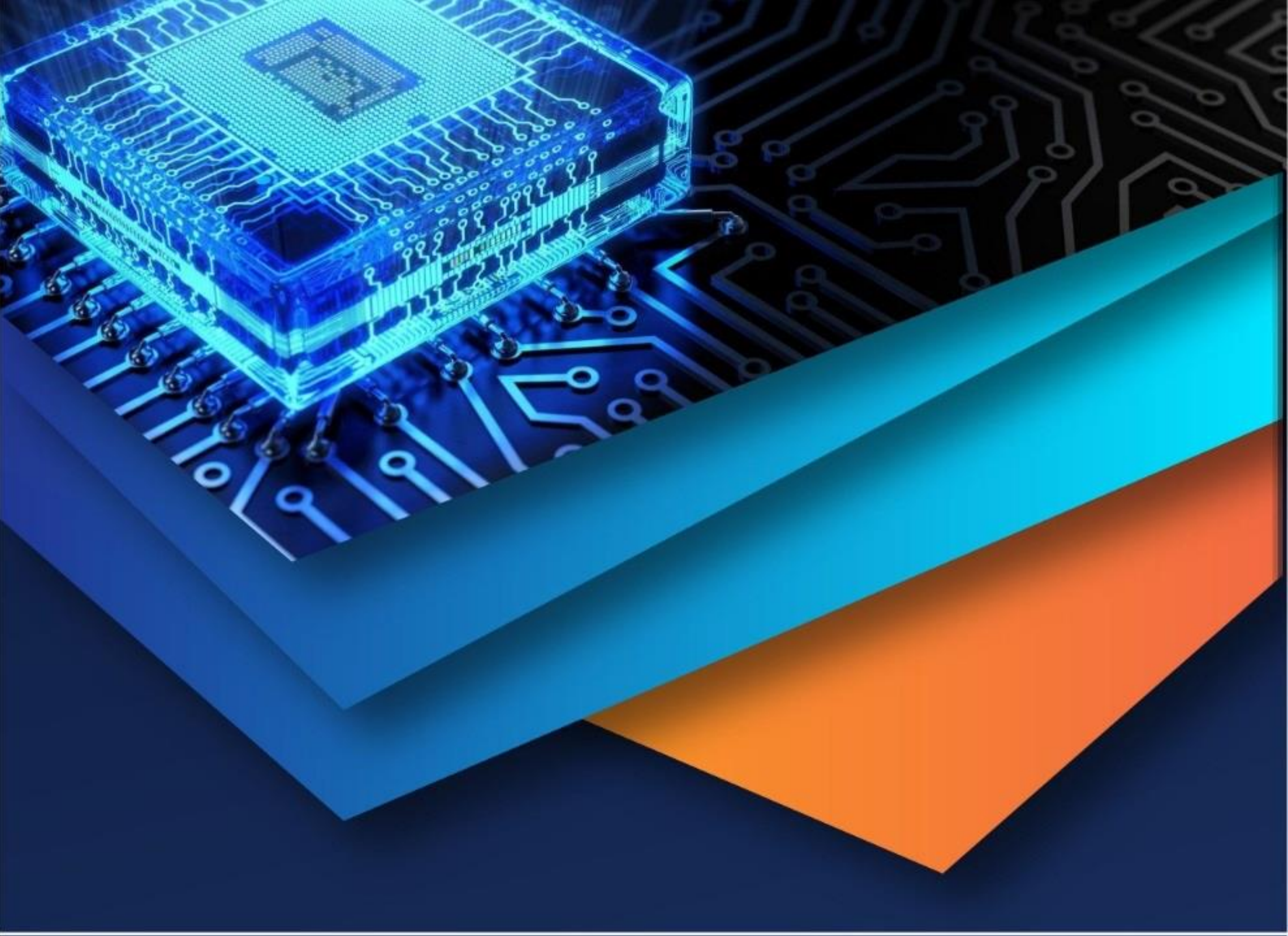
[9] About GRIHA ://www.grihaindia.org/about-griha



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