An economical and comparative analysis of energy conservation requirements: An approach to get the star rating of Green buildings

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Abstract - Throughout the world, the real estate sale and *purchase are done on the basis of the comfort and ease of living. That is the reason why we give emphasis on designing the buildings in such a way that, the internal environment is isolated from the external environment. At the same time, this leads to very high energy consumption. So, it has become very important to break this trend of constructing building, and adopt new ways so that minimal energy is consumed and maximum is saved for our future generation; without compromising the luxury. This paper is based on the implementation and simulation after the*
analysis of a building and will rate it as per the guidelines for providing an energy star rating. Here we will study in practical about the energy efficiency of the building by taking the conventional loads and also by implementing energy star rating. Finally by taking down the readings we will draw the simulation curve and will see how much energy consumption is reduced and the energy performance of the building by using energy star rating.

Key Words: BEE, GRIHA, LEED, Green building, ECONIRMAN

1. INTRODUCTION

Energy conservation in simple terms is avoidance of wastage of energy without sacrificing comforts & requirements. Energy Conservation Act was enacted in Parliament, in 2001 by Govt. of India setup Bureau of Energy Efficiency (BEE), a statutory working body under Ministry of Power, on 1st March 2002, under the necessities of the Energy Conservation Act 2001. One of the dictatorial functions of BEE, under this Act, is to develop minimum Energy Performance Standards & Labelling, for equipment/appliances and buildings. With the help of this governing body the star rating or labelling is done.

2. STAR RATING IN INDIA

It is an energy efficiency rating scheme for Electrical appliances and Buildings are set by the Bureau of Energy Efficiency (BEE). The rating will rank equipments and buildings on their energy efficiency, starting from one star for the least energy efficient and up to five stars, for the most energy competent. Star Labels have been shaped to regulate the energy competence ratings of different electrical appliances and indicate energy expenditure under standard test conditions.

To be more precise, BEE has developed the Energy Conservation Building Code (ECBC) which provides minimum energy performance standards for energy efficient business buildings with a connected load of 100 kW and above. The ECBC is currently a deliberate program, with a number of states adopting it as a obligatory requirement. Further both Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) rating systems have adopted ECBC as a minimum fulfilment requirement. BEE has urbanized a Star Rating program for buildings which is based on the actual concert of a building in terms of its specific energy usage in KWH/sq m/year. This program rates office buildings on a 1 to 5 Star scale, with 5 Star characterized buildings being the most efficient.

3. OBJECTIVE OF STAR RATING

It provide the consumer an informed choice about the energy savings, and thereby the cost saving potential of the labelled household products and other electronics and electrical products. Consumer can aware about the energy saving potential along with the available products. The cost saving potential of the marketed house hold and other equipments. It creates a command in the market for Energy Efficient equipments. The impact the energy saving in the medium and long run. With this the position of domestic industry can compete in international markets where norms for energy efficiency in many countries are mandatory.

4. STAR RATING EQUIPMENTS

According to the guidelines of Bureau of Energy Efficiency, all the new buildings have to be equipped with the labelled appliances. Minimum Three Star Rated appliances should be used. From January 7, 2010, it was made mandatory to various appliances to be labelled with stars so as to be used in the houses and new buildings. Star rating equipments are the various equipments that we use in daily life. As they are used on a daily basis, so the power consumption is also more. A single house has a minimum of fans, lights, refrigerator, AC, and few others; which consumes power in

KWH. When it is seen on a basis of complete locality, the power consumption would be more than thousands of KW.

5. STAR RATING BUILDINGS IN INDIA

Is it an Economical and Comparative investigation of Energy Conservation Requirements: An Approach to Get the Star Rating of Green Buildings 5 India has also joined the race. It started to mirror the global trend when LEED India Programme was tailored from United States Green Building Council's LEED (Leadership in Energy and Environmental Design) in 2007. This is purely a private programme which is run by the Indian Green Building Council (IGBC) in India. The IGBC, which is part of the Confederation of Indian Industries - Sohrabji Godrej Green Business Centre (CII-GBC), has been promoting management in Energy and Environmental Design (LEED) now for a decade. According to IGBC website, LEED India works on a whole-building move towards to sustainability by recognizing presentation in the five key areas namely sustainable site growth, water savings, energy efficiency, materials selection and, indoor environmental quality. LEEDINDIA programme includes LEED India for New Construction (LEED India NC) and LEED India for Core and Shell (LEED India CS).

Green Rating for Integrated Habitat Assessment (GRIHA) which has been conceived by the Energy and Resources Institute (TERI) and jointly developed by Ministry of New and Renewable Energy (MNRE) as the national rating system for buildings. GRIHA was adopted as the National Rating System (NRS) under the MNRE, as of 1 November 2007. It is a green building 'design evaluation system', and is suitable for all kinds of buildings in different climatic zones of the country. According to GRIHA website, GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and optimize the same to the best possible extent.

6. STAR RATING CRITERIA

TERI, being deeply devoted to every aspect of sustainable development, took upon itself the liability of acting as a driving force to popularize green building by budding a tool for measuring and rating a building's Environmental presentation in the context of India's varied climate and building practices. The rating system referred as 'Green Rating for Integrated Habitat Assessment' (GRIHA) quantifies parameters like energy expenditure, waste generation, renewable energy acceptance over the entire lifecycle of the building. GRIHA has set up various parameters towards the building of new buildings. According to the present GRIHA parameters there are 34 criteria of the GRIHA rating system under four main categories: Selection and site preparation, preservation and efficient utilization of property, Building operation and preservation, Innovation.

7. ENERGY STAR LABEL FOR EQUIPMENTS

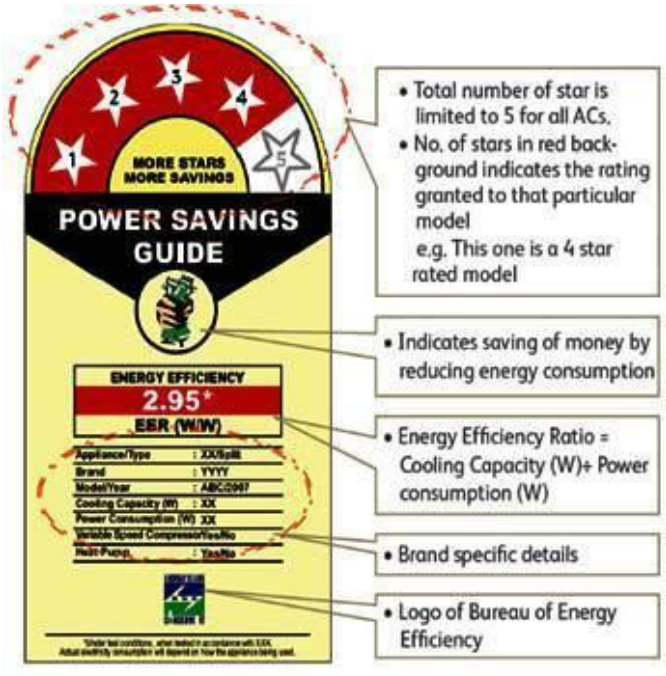

Fig -1: Energy Star Level

8. ENERGY PERFORMANCE CERTIFICATION OF BUILDINGS

Energy performance documentation provides a means of rating individual buildings – whether they be residential, commercial or public – on how efficient (or inefficient) they are in relation to the amount of energy needed to provide users with accepted degrees of console and functionality. The degree of competence depends on many factors including: local climate; the design of the building; building methods and materials; systems installed to provide heating, exposure to air, air condition or hot sanitary water; and the appliances and equipment needed to support the functions of the building and its users. Clearly, documentation is a complex procedure, requiring in-depth knowledge of building components. It also reflects increasing gratitude of the need to think of buildings as "integrated systems", rather than simply the sum of their parts.

9. ENERGY PERFORMANCE ASSESSMENT

In order to organize an energy certificate, it is first essential to undertake an energy routine assessment of the building's description and systems. This is carried out by a qualified assessor who collects information on the building's description and components, as well as its energy systems and energy consumption. An assessment usually includes, as a smallest amount, an analysis of: The form, area and other details of the building, the thermal, solar and daylight properties of the building cover and its air permeability, space heating fixing and hot water supply, including their efficiency, responsiveness and controls, ventilation, air-

conditioning systems and controls, and fixed lighting, fuel and renewable energy sources.

10. ISSUANCE OF BUILDING CERTIFICATES

The building certificates may be subject for new and existing buildings. The timing of issuance is important because it can verify the efficiency of the certification and its prospective to have a positive impact on the building's energy performance level. Another issue that influences the impact of certification is whether the system is voluntary or compulsory. Voluntary official recognition is often considered a type of "positive branding" for builders that are keen to "advertise" the high stage of energy performance their buildings attain. But as builders achieving lower performance buildings will not "opt in", voluntary schemes tend to identify only the most efficient buildings. In contrast, mandatory schemes applied to a maximum number of buildings help to identify the most inefficient buildings and often provide advice on how to improve energy ratings.

11. THE POLICY PATHWAY

The way to energy certification of buildings involves four stages which are Plan, Implement, Monitor and Evaluate – under which fall ten critical steps. The approach outlined below is based on country experiences, and follows the decisions that paved the way for flourishing and cost-effective functioning. To date, most countries have opted to apply voluntary rather than compulsory building certification schemes. However, energy certification of buildings became obligatory under the Energy Performance in Buildings Directive (EPBD), which aims to help get better energy performance and diminish associated CO2 emissions. The EPBD also requires all member states to develop methodologies for energy certification for all buildings when sold or let. Some countries have fully implemented the requirements of the EPBD, both in spirit and in law, and are currently issuing energy concert certificates for new and existing buildings. These two countries are excellent examples of high-quality certification schemes that both provide an energy performance rating and contribute to increased consciousness of low-energy building. These countries are using the certification scheme to transform the energy performance of their individual building stocks.

12. GREEN BUILDING

A Green Building is one which utilizes less water, optimizes energy competence, conserves natural property, generates less ravage and provides improved space for occupants as compared to conventional buildings. Green building is also known as sustainable building which refers to both arrangement and the using of processes that are environmentally responsible and efficient throughout a building's life cycle which is from citing to design, construction, operation, maintenance, renovation, and demolition.

The green building process integrates environmental considerations into every point of the building construction. This procedure looks on the design, construction, operation and maintenance phases and takes into account the lot design and growth efficiency, energy and water efficiency, resource efficiency, indoor environmental quality, building-owner maintenance and the building's overall impact on the environment.

Green building design engages to find the balance between home building and the sustainable environment. This requires close collaboration of the planning team, the architects, the engineers, and the customer at all project stages. The Green Building practice expands and balance the classical building design concerns of economy, utility, durability, and comfort.

13. GREEN BUILDING TECHNOLOGY

In green building, 10 major technologies are normally used to fulfil the building construction. They are:

13.1. Zero Energy Home:

Zero energy homes are particularly built to be particularly energy efficient with brilliant insulation and techniques like passive solar design. Of course, efficient plan is just to start the buildings still need power from somewhere. Active solar panels and wind collectors are frequent solutions, while some buildings use bio fuels for heating. Zero energy building is most efficient in small communities where several homes can benefit from a shared renewable resource.

13.2. SMART APPLIANCES

Today's contemporary appliances are smarter than ever. Our kitchens might not look like somewhat out of the quite yet and there is still no Rosie around to cook and clean, but the latest appliances are designed to accumulate energy and simplify our lives.

13.3. ELECTROCHROMIC SMART GLASS

Smart glass which is also known as electro chromic glass uses a tiny burst of electricity to charge ions on a window layer due to which it changes the amount of light it reflects. While low emittance windows that block some of the sun radiation already exist where as smart glass gives you the ability to choose how much light you want to block.

13.4. SOLAR POWER

Solar power doesn't essentially require tons of equipment. In fact few solar powers don't require any equipment at all. There is a difference between active solar power what you

most likely picture when you think of solar energy and passive solar power, which is based on smart home design rather than advanced technology.

13.5. GEOTHERMAL HEATING

Geothermal energy initiates from the heat retained within the Earth since the original creation of the planet, from radioactive decompose of minerals and from solar energy absorbed at the surface. Most high temperature geothermal heat is harvested in regions close to tectonic plate boundaries where volcanic movement rises close to the surface of the Earth.

13.6. STORM WATER MANAGEMENT

Storm water management used to dictate getting water off the site as quickly as possible. That has only established to push the problem downstream and the compensation caused is many. We have over remunerated our collective wish to escape getting "stuck in the mud". Hard paved surfaces, such as roads and parking lots, quickly transport water to municipal storm drains. This surge on the storm sewer system results in flash flooding and higher customer costs in water related infrastructure.

13.7. RAMMED EARTH BRICK

Rammed earth is a mixture of clay rich soil, water and a natural additive such as animal urine, animal blood, plant fibres. It is dense inside temporary forms until it hardens. The resulting arrangement can withstand pressures up to 400 psi. That's about 10% of the pressure modern bricks can tolerate. Rammed earth walls can be reinforced with timbers or latticework made of bamboo.

13.8. BIODEGRADABLE MATERIALS

Since manufacture is all about building something new, we sometimes not remember about the flip side of the coin which is tearing something down and disposing of building materials. Biodegradable materials can change that discarding process into something more eco-friendly i.e Instead of a giant scrap heap of waste products and chemicals, they result in products that degrade naturally without contaminating the soil.

13.9. GREEN INSULATION

Sustainable building starts with plummeting the heating and cooling loads of the home as much as possible and insulation is the key to energy preservation, a keystone of green building. Well-insulated houses not only save energy, thus lowering effective costs, but also keep people more relaxing.

13.10. COOL ROOFS

Cool roofs are particularly designed to offer augmented solar reflectance and decreased thermal emittance. They replicate more of the sun's rays than your average shingle roof and avoid the warm or cool air inside from absconding in the course of the top of a building. Under the powerful heat of the summer sun, dark shingle roofs can reach temperatures of 150 degrees Fahrenheit (65.5 degrees Celsius). The reflectance of a cool roof can cut that down by more than 50 degrees.

14. ECONIRMAN

Econirman whole building performance tool is an online tool to determine conformance with the ECBC using the Whole Building Performance (WBP) method. It enables building developers and designers to examination their building design using the energy simulation protocol established.. The tool also forecasts the performance of the building in terms of its annual energy consumption normalized to the building area. Being a web based energy simulation tool, it can be made available to users over the Internet with minimal software requirements and building science or simulation expertise.

The tool runs the Standard Design (baseline parameters from the ECBC prescriptive requirements) and the Proposed Design (user specified inputs that allow the user to modify the ECBC prescriptive requirements) versions of the building and compares the Energy Performance Intensity (EPI) from the simulation results. A report that may be submitted to demonstrate conformance with the ECBC, can be generated.

14.1. Parameter Used

14.1.1. Building Use

The Building Use tab is used to define space use and zoning. The tab comprises of two sub-tabs on the left side that are explained in the following sub-sections.

14.1.2. Space use

This sub-tab is used to define the area allocated to each space type and the corresponding loads, lighting details, thermal comfort, and operating schedules.

14.1.3. Area Allocation

Against each space type, enter the area to be allocated to it under the Allocated Area (m2) column. The total area allocated to all space types must be equal to the total Interior Floor Area.

14.1.4. Zoning

This sub-tab is used to provide the information to generate the thermal zones of the building. Econirman WBP Tool uses the building geometry (shapes, dimensions, and orientations), the specified space types, and zoning affinities to create the zones for both the Proposed Design and the Standard Design models.

14.1.5. Envelope.

The building envelope refers to the exterior façade and roof, and is comprised of opaque components and fenestration

systems. Opaque components include walls and roofs; fenestration systems include windows and skylights. The envelope protects the building's interior and occupants from the weather conditions and shields them from other external factors such as noise and air pollution. Envelope design strongly affects the visual and thermal comfort of the occupants, as well as the energy consumption of the building.

14.1.6.U-factor (Thermal Transmittance)

It is nothing but the heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side.

14.1.7. Windows and Walls

This sub-tab is used to define the construction and Window Wall Ratio (WRR), and vertical and horizontal shading.

14.1.8. Window Wall Ratio

This is the ratio of the vertical fenestration (window) area to gross exterior wall area. The gross exterior wall area is measured horizontally from the exterior surface; it is measured vertically from the top of the floor to the bottom of the roof.

14.1.9. Shading

The overhangs on a building can reduce solar gains. The inputs for both horizontal shading devices and vertical fins that extend out of a building can be provided in the tool.

14.1.10. Roofs and Skylights

This sub-tab is used to define the construction of building roofs, the skylight roof ratio (SRR), and the roof reflectivity.

14.1.11 Skylight Roof Ratio

This is the ratio of the total skylight area of the roof, measured to the outside of the frame, to the gross exterior roof.

15. SIMULATION RESULT

ENERGY CONSERVATION BUILDING CODE (ECBC)

ECO nirman Whole Building Performance

Conformance Check Report
Whole Building Performance Method

1.0 Building Summary

Project Information		
Project ID	d6c50c42-2fcc-4107-bac5-299d09176bc4	Date: 4/3/2016
Project Name	certification of building	
Project Address	GUNUPUR	
Organization Name	GIET	
Building		
Building Type	Office	
Building Occupancy	Daytime Use	
Total Conditioned Area (m²)	171	
Total Unconditioned Area (m²)	25	
Total Interior Floor Area (m²)	196	
Number of Floors	1	
Floor to Floor Height (m)	4	
Location		
State/UT	Orissa	
City	Rayagada	
General		
Climate Zone	WarmAndHumid	
Weather File	IND_Vishakhapatnam_431500_ISHRAE	
Simulation Program	DOE2.1	

Building Conformance Summary

Proposed Design Electricity Use per year (kWh/year)	Standard Design Electricity Use per year (kWh/year)	Percent Savings: Electricity Use per year
55,806	74,097	24.7%
Proposed Design EPI (kWh/m²/year)	**Standard Design EPI** (kWh/m²/year)	**Percent Savings: EPI**
285	378	24.7%
10.3.2(e) of ECBC Satisfied (Y/N)?		Y
Mandatory Requirements Met (Y/N)?		N

Building Conformance as per the ECBC	NON-CONFORMING

Fig -2: Building simulation summary

7.1 Standard Design - End Use Summary

End Use	Energy Type	0° rotation		90° rotation		180° rotation		270° rotation		Average	
		Energy Use (kWh)	Peak Demand (kW)	Energy Use (kWh)	Peak Demand (kW)	Energy Use (kWh)	Peak Demand (kW)	Energy Use (kWh)	Peak Demand (kW)	Energy Use (kWh)	Peak Demand (kW)
InteriorLighting	Electricity	8,140	2	8,140	2	8,140	2	8,140	2	8,140	2
InteriorEquipment	Electricity	9,588	2	9,588	2	9,588	2	9,588	2	9,588	2
Cooling	Electricity	55,460	16	55,683	16	55,799	16	54,985	16	55,482	16
Fans	Electricity	888	0	886	0	883	0	894	0	888	0
Totals		74,076	20	74,297	20	74,410	20	73,607	20	74,098	20

Fig -2: Standard Design

7.2 Performance Rating Table

End Use	Energy Type	Proposed Design		Standard Design (Average)		Energy Percent Savings
		Energy Use (kWh)	Peak Demand (kW)	Energy Use (kWh)	Peak Demand (kW)	
InteriorLighting	Electricity	8,140	2	8,140	2	0.0%
InteriorEquipment	Electricity	9,588	2	9,588	2	0.0%
Cooling	Electricity	37,393	11	55,482	16	32.6%
Fans	Electricity	684	0	888	0	23.0%
Totals		55,805	15	74,098	20	24.7%

Fig -2: Performance Rating

7.3 Energy Consumption

Energy Type	Energy Use (kWh)		
	Proposed Design	Standard Design	Percentage Improvement
Electricity	55,806	74,097	24.7%
Totals	55,806	74,097	24.7%

Fig -2: energy Consumptions

16. CONCLUSION

With India facing rapid urbanization, globalization and expanding economy, it is experiencing a rapid spurt in building construction across a range of city activities and socio-economic spectrum, increasing consumption of building materials such as glass, cement, metals and ceramics. Uncurbed consumption of these high embodied energy materials is a reason for environmental degradation. In today's era where energy crisis is a major problem, green buildings gives a brilliant and promising solution. These are designed to use minimum energy. All the systems for cooling, heating, ventilating are designed such that they require very less energy.

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