Advanced Materials Research Vol. 748 (2013) pp 1125-1129

doi:10.4028/www.scientific.net/AMR.748.1125

Design and Development of Low Cost Certified Green Building for Non Residential Existing Building (NREB)

Kassim A.M [1,a], Jamri M.S[1,b], Othman M.N[1,c], Rashid M.Z.A[1,d], Ismail S. J. S[2,e]

[1] Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka

Durian Tunggal, Melaka, MALAYSIA

[2] Menara Teknik, Taman Pandan Mawar, Jalan Pandan, Melaka, MALAYSIA

[a]anuar@utem.edu.my, [b]saifuzam@utem.edu.my, [c]nazri@utem.edu.my, [d]zamzuri@utem.edu.my, [e]sheikhjaafar@yahoo.com

Keywords: Green building index, non-residential existing building, low cost

Abstract. The Green Building Index (GBI) is one of rating tool which are provides a prospect for building developers and owners for designing and constructing a green and sustainable buildings. The proposed low cost GBI buildings provide many advantages such as energy savings, water savings, a healthier indoor environment, and better connectivity to public transport. Besides, adoption of recycling and greenery for the projects and can reduce the impact on the environment. However, the implementation to certify as Green Building Index has a lot of concerns such as cost constraint, know how constraints and etc. Therefore, in this paper, the design and development of low cost certified green building by fulfilling the Green Building Index (GBI) is proposed in order to ease the development of green building to have better life for human and environment in this world in term of energy efficiency performances.

Introduction

Recent years, the global warming is affecting whole over the world where average temperature of the Earth atmosphere has increased compared to the 19th century. Thus, the global solutions are required in order to face the challenges to planet particularly on climate change and sustainable economic development. The major part of this global problem is construction sector which are consumed about 40% of the world's energy, 12% of it is water and also gives 40% of the waste directed to landfill. Nevertheless, the construction sector also can be the main contributor of the solution. The World Green Building Council (WGBC) is working within the Asia-Pacific region to promote the benefits of sustainable building practices, and Malaysia has embraced the potential of green building [1].

The global effects cause by carbon emissions and the result of climate change are clearly stated in many publications. It is because of the products of civilization such as buildings, cities and the built environment. The increasing of carbon emissions is clearly stated which cities development contributes significantly to climate change. Though, by applying the GBI rating tool, the development of more environment-friendly will be proposed. GBI is proposed in Malaysia as green rating tool for buildings and towns in order to create promotion of sustainability in the built-environment and raise awareness of environmental issues amongst developers, architects, engineers, town planners, along with the public. Therefore, future generations can look forward the brighter and greener future which will be faced.

Many of international and national research study are confirmed that the building which are classified as green buildings are consuming less water, energy and can reduce waste and also can make a healthy and comfortable environment for the building users. Almost of the green building performance can cut a building's operation costs about 9% and at the same time can increase building values by 7.5% and comprehend a 6.6% increase in return on investment (ROI) [2]. Hence, green buildings don't just make sound ecological and environmental sense which also makes sound economic sense too. In this paper, the design and development of low cost certified green building by fulfilling the GBI is conducted in order to ease the development of green building to have better life for human and environment in this world in term of energy efficiency performances.

Project Background

This project basically is a renovation project of an existing double storey shop office building for ASR Padu Sdn. Bhd which is located in Taman Paya Emas, Melaka. ASR Padu building redevelopment consists of ground floor and first floor corner lot shop house which comprises room for director, chief operating officer (COO), workstation, discussion room, reception counter, printing room, account room, CEO room, meeting room, prayer room, for male and female which are consist two storey of office building. ASR Padu existing building objective is to obtain at least the minimum GBI Certified Rating. By establishing energy efficiency (EE) performance in the ASR Padu building redevelopment, the thermal comfort, energy consumption in the building could be reduced as well as carbon dioxide emission to the atmosphere will be reduced.

The office building was proposed for refurbishment and upgrade GBI certification which comprises new façade on its current building. Refurbishment of the shop house interior and exterior includes replacement of glazing and remodeling of some areas in the shop interior. Figure 1 shows the illustration of exterior of ASR Padu Sdn. Bhd.

Fig. 1 Exterior of ASR Padu Sdn. Bhd

Table 1 Building parameters

Item	*Parameter*	*Unit*
Total AC Floor Area	1000.0	m^2
No. of floors (including ground)	3.0	floors
Floor to floor height	3.3	m
Aspect ratio	0.65	to 1
Building orientation	South	
Floor area per floor (Roof area)	333	m^2
Building length (Local North)	14.7	m
Building width	22.6	m
Total wall area	739.8	m^2

Green Building Index (GBI)

In order to certify the building as green building, there are six criteria's which have to achieve. The criteria which have been assessed the building such as Energy Efficiency (EE), Indoor Environmental Quality (IAQ), Sustainable Site Planning (SM), Material & Resources (MR), Water Efficiency (WE) and Innovation (IN). Figure 2 shows the distribution of point which must be achieved in order to obtain the GBI Certified Rating for Non Residential Existing Building (NREB). The green building index is focuses on increasing the efficiency of resource use such as energy, water, and materials while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance, and removal. Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings [2].

The Energy Efficiency (EE) has major point for the NREB which is used to improve energy consumption by optimizing building orientation, minimizing solar heat gain through the building envelope, harvesting natural lighting, adopting the best practices in building services including use of renewable energy, and ensuring proper testing, commissioning and regular maintenance. Then, the Indoor Environmental Quality (IAQ) is used to achieve good quality performance in indoor air

quality, acoustics, visual and thermal comfort. These will involve the use of low volatile organic compound materials, application of quality air filtration, proper control of air temperature, movement and humidity.

On the other hand, the Sustainable Site Planning (SM) is used for selecting appropriate sites with planned access to public transportation, community services, open spaces and landscaping. Besides, it also included the avoidance and conserving environmentally sensitive areas through the redevelopment of existing sites and brown fields by implementing proper construction management, storm water management and reducing the strain on existing infrastructure capacity. In addition, the Material & Resources (MR) is used to promote the usage of environment friendly materials sourced through sustainable sources and recycling by implementing proper construction waste management with storage, collection and reuse of recyclables materials, construction formwork and waste from the constructions.

The fifth elements of assessment is on Water Efficiency (WE) which is applied the rainwater harvesting system by using water recycling and water-saving fittings. By using this system, the usage of water inside the building can be optimized and reduced. Besides, the outside water usage such as irrigation system also can reduce the usage of water. The Innovation (IN) also one of the criteria's to obtain the certification of Green Building Index. The innovative design and initiatives which is met the objectives of the GBI also can make the building classified as Green Building Index. Achieving points in these targeted areas will mean that the building will likely be more environment friendly than those that do not address the issues. [3]

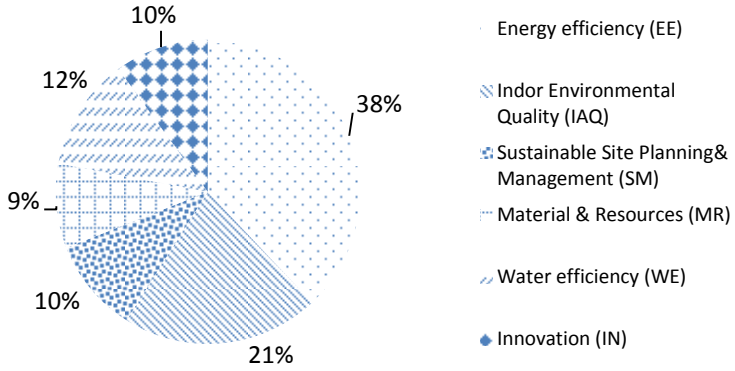

Fig. 2 Distributions of point for GBI Rating

Table 2 GBI classification

Class	*Point accumulated*
Platinum	86 and over
Gold	76 to 85
Silver	61 to 75
Certified	50 to 60

In order to have the rating for GBI building, some points have to collect from each category. There are some levels which are set as a classification of GBI rating which can be illustrated in Table 2. Each category has the maximum point which has to collect. The requirement which can be claimed must have some design, calculation and justification for each point.

Strategies and Results

In the ASR Padu building redevelopment project, the minimum requirement which have been set by Green Building Index Non Residential Existing Building (GBI NREB) is to establish minimum Energy Efficiency performance. Figure 3 shows the result of the submission to get the certification GBI from the MGBC Sdn. Bhd. Here, the minimum point for GBI NREB EE1 points is 2 point by achieving the Overall Thermal Transfer Value (OTTV) by $\leq$ 50 W/m^2 which is 33.45 W/m^2 by using the IES-VE computational modeling software and Roof Thermal Transfer Value (RTTV) by

≤ 25 W/m^2 which is 4.54 W/m^2 by using the same software. However, the Energy Management Control System is not been proposed because of the air conditioning space is only 584.67 m^2 which is less than 4000 m^2.

In addition, the Lighting Zone is the EE2 requirement where 3 points can be claimed. ASR Padu building redevelopment included 540.30 m^2 Nett Lettable Area (NLA). Thus, the size of individually switched lighting zone must not exceed 100 m^2 for 90% of the NLA in order to meet the requirement of lighting switch design. The lighting zone strategy is applied for providing the flexible lighting controls to optimize energy saving in the building. On the other hand, the technology of daylight sensor and motion sensor also been implemented at the dedicated area in order to complement lighting zone for 25% of NLA.

The daylight sensors are implemented in this project and installed at the building perimeter zone for energy efficiency. The position of the daylight sensor is based on the daylight penetration result from the day lighting modeling. Instead of using daylight sensors, the individual light switches also been installed in order to turned off the after the office hours to prevent the activation of the light sensors during night time. Besides, the motion sensors are installed in the common areas which are less frequently usage in the building such as filling& utility room, toilet, pantry and etc. the motion sensors installed will send a signal to the light fitting if it detects no movement in the zone after an assigned period of time.

In addition, the Electrical Sub metering (EE3) is a sub category which is easily can be claimed. The maximum points can be claimed is 2 points. The requirements to claim this point are by providing separate sub-metering for all energy use ≥ 100 kVA and provide separate sub metering for lighting and power at each floor. However, there are no points is claimed under the Renewable Energy (EE4) sub category where this category is the highest cost per point. For EE5, the assessment has been undertaken to determine whether the project achieve credit points for the Advanced or Improved Energy Efficiency performances under GBI for NREB. The Building Energy Intensity (BEI) of the project is calculated and the energy consumption by the building is expressed as the percentage of the building annual energy use to determine whether the office building qualifies for pints in EE5 category. The office building strategy can be divided into two categories which is the passive design and the active design. Passive design integrates with the environment meanwhile an active design integrates itself with electrical appliances.

For the passive design, it is included the glazing, insulation and ventilation design for the building. Glazing that have been installed is provided natural shading from the sunlight into the building. The glazing types which have been proposed are *tempered* material for Ground floor and *Indoflot clear* for first floor. A low transmittance value of material is main point how well the material can absorb heat. The lower the value is the better the absorption rates become. In term of wall and roof materials, it will influence the OTTV and RTTV value. Materials with high thermal conductivity represent a faster rate of heat through the medium and vice versa with low conductivity value. A proper material selection base on is conductivity value is vital in order to achieve low OTTV value. It also can be referred for the RTTV.

In addition, additional cooling method is required in order to maintain a temperature level of 24 degrees Celsius based on the requirement in MS: 1525, this can be achieved by implementing active design strategies. The strategies which are under description of active design are by utilizing electricity and heat produce from the appliances. There are number of strategies which are implemented for achieving thermal comfort such as air-conditioning strategy, air ventilation strategy, active lighting strategy and internal loads. For air condition strategy, the internal load for the air conditioning loading calculation is 6 W/m^2. The air conditioning cooling capacity is matched according to the heat being generated in respective areas. There are three types of air conditioning system have been used such as York Prestige 2, York Cooling King Ion Air and York Air Surround where York Prestige 2 and York Cooling King Ion Air are wall mounted units.

For the air ventilation strategy, the Airegard AH-150T is used in order to supply fresh air into the building on each floor. The ventilator generated a power output of 60W each and contributes a BEI value of 0.46 kWh/m^2/year and supplies fresh air at a rate 120 cubic foot per minutes (cfm). In term

of active lighting strategy, the usage of motion sensor and daylight sensor is proposed in order to reduce the energy consumption. Lighting used in ASR Padu Sdn. Bhd. office building are energy efficient as it has low in wattage and contributes 3.47 kWh/m^2/year of energy. On the other hand, an internal loads are heat which generated by humans and electrical appliances. The total heat which is assumed by the internal loads is 19,787.93 W where this amount of heat has to be dissipated by the air conditioning system in order to achieve thermal comfort of the building's interior. From the energy calculation, the energy consumption of the electrical appliances is shown in Table 3 and achieved BEI 99.53 kWh/m^2/yr which is equivalents to 12 points.

Table 3. Plug loads

Item	*No. of units*	Power consumption/year (kWh/yr)	*BEI (kWh/m^2/yr)*
Lighting	126	1020.05	1.67
Air conditioning	16	49,145.06	86.43
Water heater	1	322.80	0.71
Wall fan	4	240.00	0.35
Personal computer			
1. LCD Monitor	5	774.72	1.36
2. Laptop	44	2556.57	4.50
Photocopier and laser printer	2	645.60	2.04
Water dispenser	2	74.00	0.47
Refrigerator	2	200.00	1.54
Room ventilation	2	120.00	0.46
Total (kW/h)		56,389.29	99.53

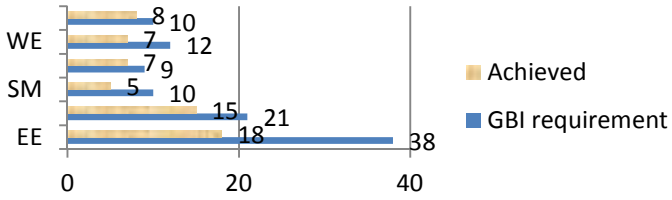

Fig 3. Achievement of points for each category

Conclusions

From this paper, the design and development of the low cost certified Green Building have been proposed especially for the energy efficiency performances. From each sub criteria, there are some strategies which must be done and involved low cost budgeting. The optimization of the strategies and the point have been done in order to have the very effective green building and at the same time the energy saving.

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