Energy Efficiency Criteria for Planning and Design of Green Hospital Buildings Rating System

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Abstract

Energy efficiency in buildings nowadays are objectively important to be achieved and it requirements being underlined in energy policy for buildings at regional, national and international levels. It circulates among the utilization of building services. This paper analyses available information concerning energy efficiency criteria for hospital buildings, whereby particularly, most hospital buildings are operating in 24 hours with high energy consumption. An analysis of green hospital development is conducted and is aimed to emphasize the important aspects energy efficiency applies in hospital building. An overview related to the present sustainable energy efficiency practices that influential green hospital building planning accomplished by a matrix survey is presented. This gives the possibility to assess the motivation for a sustainable or green hospital buildings development through building rating system. Attention is devoted to the review of energy efficiency criteria as they have to be introduced in the future planning and design of green hospital buildings. Several criteria are listed and their relevance to the sustainable energy development for green hospital building development is accessible. The results indicate that several significant criteria for sustainable hospital can improve the practices of energy efficiency to hospital buildings at the planning and design stages. The energy efficient criteria in green hospital building rating system is potential in providing a positive contributions to energy engineering science, which also may lead to more reduction of hospital building energy consumption, thus, directly improve the carbon footprints.

Keywords: Energy efficiency, green criteria, hospital building, green building, rating system

1. INTRODUCTION

In 2003 a survey carried out by yellow pages attempted to identify changing attitudes to modern lifestyles [1]. People aged 22 – 44 were asked what 24/7 (24 hours per day, 7 days per week) goods and services they would most like to see available in their area. The most requested round-the-clock service was health care, with just under two-thirds of people wanting to be able to contact their doctor, dentist or local pharmacy at any time day or night.

The most obvious result of these changes is that people will be spending more money on electricity. A substantial minority of households is fuel poor, however the official definition is that they are spending more than 10% of their disposable income on heat and light. Normally the increasing electricity consumption might affect electricity prices. The non-stop society forces consumers to adopt lifestyles which are unsustainable [2].

The International Energy Agency and other global organizations estimate approximately 2.6 billion people in developing countries – more than one-third of the world’s population – rely on biomass for cooking. An additional 200-300 million people rely on coal for cooking and heating.
purposes. All this has serious consequences for human health; about 3.5 million people die prematurely each year from exposure to indoor air pollution from these practices. Access to modern energy sources and advanced technologies could cut this loss of life significantly [3]. Technology and energy work together to provide practical solutions. This is what makes modern living standards possible.

i. **Productive workspace**

Before the late 19th century, office buildings generally did not exceed five stories because of construction costs and the lack of elevators. Steel frame construction, elevators, electric lighting and air conditioning enabled taller buildings, which maximized real estate. Modern insulation, lighting and temperature control have greatly improved commercial building energy-efficiency [3].

ii. **Modern manufacturing**

Prior to the Industrial Revolution, factory locations were near fast-flowing streams to use water power. The invention of the steam engine helped accelerate the Industrial Revolution and the demand for coal. Modern manufacturing equipment now requires energy dense fuels like natural gas and electricity. Forecasting long-term energy trends begins with a simple fact: people need energy. Over the next few decades, population and income growth and an unprecedented expansion of the global middle class are expected to create new demands for energy [3].

2. **ENERGY OUTLOOK**

By 2040, the world’s population is expected to rise to approximately 9 billion, up from about 7 billion today. As the world population increases by an estimated 30 percent from 2010 to 2040, global GDP rising by about 140 percent [3]. While all countries are likely to experience economic growth, some are expected to see very rapid expansion. A closer look at these trends reveals that what really drives a country’s energy demand is not just the size of its economy or its population, but rather the interaction of the two the income level of its citizens. People on earth who use energy each day to make their lives richer, more productive, safer and healthier. It is perhaps the biggest driver of energy demand. As energy incur cost, it demands proper dealing with consumer’s income.

At the global level, depleting energy resources, increasing global warming and its adverse consequences such as rising temperatures [4], extreme weather patterns, and pollution are some key motivators driving research in this area. On the ground level, motivating end-users to conserve energy is imperative to the success of any efforts toward resolving the worsening energy crisis.

Between 2009 and 2030, the global primary energy consumption is expected to rise by 1.6% annually and Malaysia’s electricity demand is expected to reach 18,947 MW in 2020 and 23,092 MW in 2030 which is 35% increment from 14,007 MW in 2008 [5]. To further demonstrate the government’s commitment to promote low-carbon technology and ensure sustainable development while conserving natural environment and resources, NGTP2009 was launched in July 2009 by the Prime Minister of Malaysia, Datuk Seri Najib Tun Abdul Razak. The
NGTP2009’s goals are aimed at progress and improvements made in major sectors such as energy, buildings, water and waste management, and transportation as well as research and development (R&D), innovation and commercialisation through collaboration with local and multi-national companies by the utilisation of RE and promotion of EE through green technology [6].

In Malaysia, on the utility side, Tenaga Nasional Bhd. (TNB) [7], Sabah Electricity Sdn. Bhd. (SESB) [8] and Syarikat SESCO Berhad (SESCO) [9] are the dominant national utility companies for electricity. These utilities are vested with electricity generation, transmission and distribution activities in Peninsular Malaysia, Sabah and Sarawak, respectively. Electricity supply is also complemented various independent power producers (IPPs), dedicated power producers and co-generators.

3. GREEN CRITERIA FOR ENERGY EFFICIENCY

Energy efficiency (EE) criteria are part of requirement for green rating system. Thus, identification of these criteria are vital in conducting this research. There are various green rating system exist worldwide. The EE criteria are extracted from existing green rating system [10].

3.1. Specific green criteria for Energy Efficiency (Hospital Building)

Little research has been done in the field of sustainability for hospitals, since sustainability is not on the priority list of the hospital boards. Therefore, it is pertinent to explore the green criteria when it comes to sustainability for the hospital building. As things stands, this study focus for green criteria specifically for Malaysia [11].

Apparently, GBI NRNC, GBI NREB and LEED show the energy efficiency is themost important criteria in rating systems [11]. The following three (3) rating systems are chosen to be reviewed in this paper as they are influential and technically advanced rating tools available for healthcare-specific building: 1. BREEAM, 2. LEED and 3. GREEN STAR. The differences between the three of them are shown in Table 1. There are several sub-criteria for energy efficiency for green rating system for planning and design of green hospital building.

4. METHODOLOGY

Green rating system for hospital building are identified in order to list down the criteria involved for green hospital. There are BREEAM, LEED and Green Star. The existing green rating system in Malaysia have been selected in order to differentiate between all rating systems used in this study. The GBI green rating system from Malaysia is chosen as it is remarkably established since 2010. Questionnaire survey has been conducted to identify the list of criteria that is deemed important in making a rank for green energy criteria for healthcare building development. Degree of importance of each criteria is determined. Likert scale are used to obtain rich data. Statistical software package is used for statistical analysis. 19 criteria are reached the design team of hospital building through survey form. In order to be able to select the appropriate method of analysis, the level of measurement must be determined. Ordinal scale was used in this research. The detail criteria have been distributed to the hospital designer in order to see the importance of each criteria.
5. RESULT

A questionnaire survey was prepared to elicit the important criteria that affects the planning and design of green hospital building. The mean values of the criteria were estimated. There are elements that were found very important and less important in this study. Detail study need to be undertaken to recognize the pros and cons for each criteria and factors influencing the selection of green hospital building. Specific energy criteria has been developed from green rating systems.
for hospital building. There are; 1. Minimum Energy Efficiency (EE) performance, 2. Lighting Zoning, 3. Electrical sub-metering, 4. Renewable energy, 5. Advanced or improved EE performance, 6. Enhanced, commissioning or Re-commissioning, 7. Post occupancy commissioning / On-going post occupancy commissioning, 8. EE monitoring & improvement, 9. Sustainable maintenance, 10. Greenhouse gas emissions, 11. Enhance refrigerant management, 12. Measurement and verification, 13. Community contaminant prevention – airborne releases, 14. Car park ventilation, 15. Efficient external lighting, 16. Sub-metering of high energy load and tenancy areas, 17. Provision of Energy Efficiency Equipment, 18. CHP community energy, and 19. Lifts. A total of 130 questionnaires were sent out to the design team of hospital building in Malaysia. This is the sample size selected for the population of design team involved in public hospital building. 90 responses were received out of the total of 130 sent out, which translates to a response rate of 64%. The acceptable useable response rate using a self-administered questionnaire is normally about 25% to 35% [12]. Demographic characteristics of the participants in this study are shown in Table 2. Table 3 shows the ranking of each criteria for green hospital building. The overall result shows that ‘advanced / improved EE performance’ criteria has been chosen as the first ranking, followed by the other 18 criteria. The last rank has gone to ‘lifts’ as least important criteria.

Table 2: Demographic characteristics of the respondent

| No | Design Team     | Total respondent (No.) |
|----|----------------|------------------------|
| 1  | Architect      | 18                     |
| 2  | Civil Engineer | 18                     |
| 3  | Structural Engineer | 18               |
| 4  | Electrical Engineer | 18             |
| 5  | Mechanical Engineer | 18            |
|    | TOTAL          | 90                     |

Table 3: Descriptive statistics of green criteria for hospital building in Malaysia.

| No. | EE criteria                                      | Mean | No. | EE criteria                                      | Mean |
|-----|-------------------------------------------------|------|-----|-------------------------------------------------|------|
| 1   | Advanced or improved EE performance             | 4.1325| 11  | Enhanced, commissioning or Re-commissioning     | 3.8313|
| 2   | Provision of Energy Efficiency Equipment        | 4.1325| 12  | Enhance refrigerant management                   | 3.8193|
| 3   | Sustainable maintenance                         | 4.0361| 13  | Efficient external lighting                      | 3.7952|
| 4   | Minimum Energy Efficiency (EE) performance      | 4.0241| 14  | Community contaminant prevention – airborne releases | 3.7831|
| 5   | Lighting Zoning                                 | 4.0120| 15  | Post occupancy commissioning / On-going post occupancy commissioning | 3.7470|
| 6   | EE monitoring & improvement                     | 4.0000| 16  | Electrical sub-metering                         | 3.7229|
| 7   | Renewable energy                                | 3.9759| 17  | Sub-metering of high energy load and tenancy areas | 3.7229|
| 8   | Combined Heat Power (CHP) community energy      | 3.9759| 18  | Car park ventilation                            | 3.6627|
| 9   | Measurement and verification                    | 3.8675| 19  | Lifts                                           | 3.6627|
| 10  | Greenhouse gas emissions                        | 3.8434|      |                                                 |
6. CONCLUSION

Proper development and operation of building projects, such as hospital building, can contribute significantly to the success of sustainable development. Green buildings make good, long-term economic sense. When systems are properly integrated, overall first costs may be lower for green buildings than for standard buildings, while operational costs are lower for green buildings. The Green development in Malaysia is an overall booming sector as there are many initiatives planned by private and public sector in promoting the environmental protection. Perhaps the identification of importance criteria will help in planning and designing hospital building in Malaysia in future.

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