Sustainable Building Retrofitting and Energy Efficiency

Authors:

Nur IzieAdiana Abidin[1], Rozana Zakaria[2], Dodo Yakubu Aminu[3]

Email:

izieadiana@utm.my[1],rozana@utm.my[2],dyaaminu@yahoo.com[3]

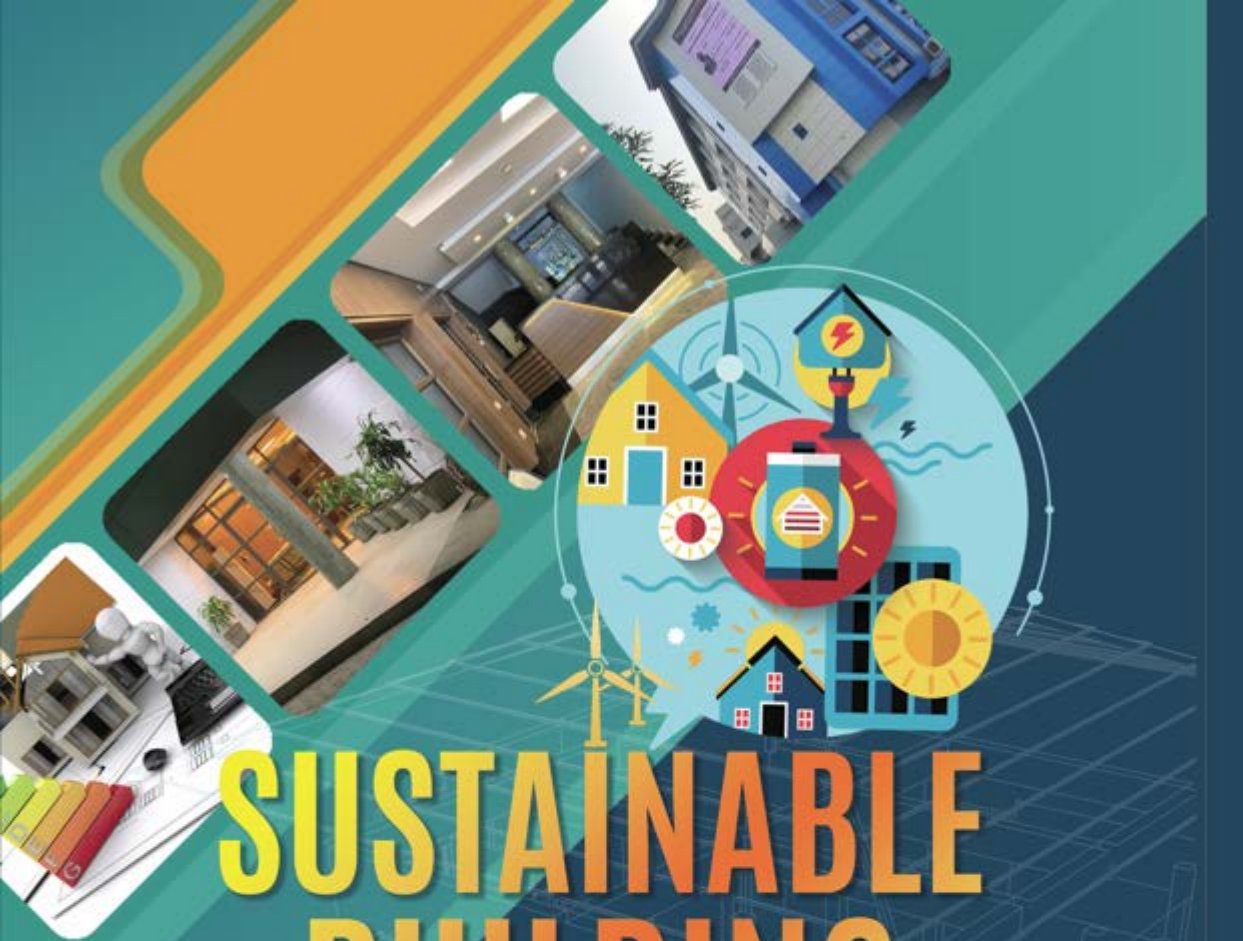
Abstract: This book introduces various topics related to energy efficiency abd sustainable retrofitting. The topics cover researches and studies on the initiatives, strategies, reduction and improvements, application, effect and approach.

Chapter 1 discussed the steps of retrofitting initiatives that can be implement to achieve building energy reduction. Retrofitting initiatives consists of three steps which are lean energy, green technology and clean energy. Chapter 2 focuses on giving an overview of green building assessment tools, the concept of retrofitting and retrofitting technologies. Chapter 3 discussed the building lighting energy simulation for retrofitting the Rest and Service Area (RSA) at Ayer Keroh Malaysia, which conducted using the Revit BIM model.

Chapter 4 presents the prototyping of retrofitting strategies in the educational building to reuse a building type or building design. Chapter 5 reveals the strategies for mitigating the influence for modernism towards sustainable retrofitting of Hausa traditional palaces. Chapter 6 presenting the attitude towards energy consumption and strategies to encourage energy efficiency in a building.

The energy consumption and occupant's well-being besed on the retrofitting implemented in the office building at National Primary Health Care Development Agency Abuja were highlighted in Chapter 7. Chapter 8 reveals cool paint application to the indoor temperature conducted at the student hostel room in UTM presidential college. Lastly, Chapter 9 highlighted the passive design approach of building envelope for individual residents in achieving energy-efficient building.

Keywords: Retrofitting, green building, prototyping, Hausa, attitude



SUSTAINABLE BUILDING RETROFITTING AND ENERGY EFFICIENCY

Nur IzieAdiana Abidin
Rozana Zakaria
Eeydzah Aminudin
Dodo Yakubu Aminu

Penerbit UTHM

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CONTENTS

PREFACE

This book introduces various topics related to energy efficiency and sustainable retrofitting. The topics cover researches and studies on the initiatives, strategies, reduction and improvements, applications, effect, and approach.

Chapter 1 discussed the steps of retrofitting initiatives that can implement to achieve building energy reduction. Retrofitting initiatives consist of three steps which are lean energy, green technology, and clean energy. Lean energy is also known as passive design, such as shading, glazing, green roof, green wall, daylighting. Green technology involves adopting technology such as occupancy sensors, automatic daylight harvesting systems, Variable Frequency Drives, energy-efficient lighting, and air-conditioning. Then, for the greatest effect of energy reduction and the demand for building energy, clean energy or renewable energy provides an opportunity for more significant energy reduction such as solar photovoltaic, wind power, and solar hot water. Chapter 2 focuses on giving an overview of green building assessment tools, the concept of retrofitting and retrofitting technologies. The retrofitting technologies categorized into three groups: supply-side management, demand-side management, and change of energy consumption pattern such as human factors.

Chapter 3 discussed the building lighting energy simulation for retrofitting the Rest and Service Area (RSA) at Ayer Keroh Malaysia, which conducted using the Revit BIM model. The simulations were performed to analyze the lighting performance and proposed retrofitting initiatives to reduce lighting consumption. Meanwhile, Chapter 4 presents the prototyping of retrofitting strategies in the educational building to reuse a building type or building design. This process needs to ensure compatibility of the design usage and functions.

Chapter 5 reveals the strategies for mitigating the influence of modernism towards sustainable retrofitting of Hausa traditional palaces. This is because traditional buildings are constructed from different materials and in different structural forms than modern buildings, and therefore, they perform differently. Thus there are some general qualities of traditional buildings that are worth defining compared to modern buildings, which require different understanding, skills, and material solutions.

Chapter 6 presenting the attitude towards energy consumption and strategies to encourage energy efficiency in a building. The attitude and strategies were obtained from a questionnaire survey conducted at the M50 office building, School of Civil Engineering Universiti Teknologi Malaysia. Consumers have shown a positive attitude towards energy savings by turning off the electrical appliances when they do not use them, utilizing natural sunlight to lighten the room, and setting up the air-conditioning temperature. Meanwhile, implementation of energy audit, information through seminars, and encouragement campaign ranked among the top 3 of other strategies to encourage energy efficiency.

The energy consumption and occupant's well-being based on the retrofitting implemented in the office building at National Primary Health Care Development Agency Abuja were highlighted in Chapter 7. This chapter aims to present the technical details of the building's current state and highlight the retrofitting projects since the building has consumed a lot of energy due to the light bulbs, heat gain from window units, continuous pumping of water, and poor indoor environmental quality. The case study grounded on 40% energy savings by providing adequate illuminance, ventilation, and thermal comfort for the occupants. Chapter 8 reveals cool paint application to the indoor temperature conducted at the student hostel room in UTM residential college. The study proved that the student's surrounding temperature in the residential college is lower after applying the cool paint. The paint also reflects more infrared light to reduce heat

absorption and decrease the level of energy consumption used to bring down the room's temperature. Lastly, Chapter 9 highlighted the passive design approach of building envelope for individual residents in achieving energy-efficient building. Selection of type, size, and location of glazing and windows at the building envelope and dominant wall areas for solar access is the most significant approach to site planning and orientation. A critical understanding of the energy efficiency problem is required in conjunction with the passive design approach of the building envelope. The related construction player should take a rule from the Overall Thermal Transfer Value (OTTV) as a tool for calculating the efficiency of the building envelope to achieve the minimum target value.

Nur IzieAdiana Abidin
Department of Structure and Materials
School of Civil Engineering
Faculty of Engineering
Universiti Teknologi Malaysia
2021

LIST OF CONTRIBUTORS

Eeydzah Aminudin
Fathihah Ahmad Shah
Monh Neardey
Nur Adleen Fitriyana Azman
Nur IzieAdiana Abidin
Rozana Zakaria
Rosli Mohamad Zin
Nadirah Darus
Safrin Rifaya Gulam Dasthagir
Universiti Teknologi Malaysia (UTM)

Ibrahim Abubakar Alkali
Bilkisu Tahir Mukhtar
Mariya Aminu Kabir
Bayero Universiti Kano, Nigeria

Haifa Youssef Hamdoun Muhammed
Faizah Mohammaed Bashir
Hela Ahmad Gnaba
University of Hail, Saudi Arabia

Hannatu Abdullahi Idris
Baze University Abuja, Nigeria

Gambo Abdullilahi
Federal Polytechnic Nasarawa, Nigeria

Yakubu Aminu Dodo
Istanbul Gelisim University, Turkey

Ogunbode Ezekiel Babatunde
Federal University of Technology, Minna, Nigeria

Nurul Noraziemah Mohd Pauzi
Curtin University, Sarawak

Zulai Jarmai Baba-Girei
Nigerian Building and Road Research Institute Abuja

Ahmad Usman Naibi
Femi Akinbogun
Icons Arkitektur -OCA, Abuja

Muhammad Mustapha Gambo
Policy, Research and Partnerships Unit, Shelter Afrique, Nairobi, Kenya

CHAPTER 1
SUSTAINABLE RETROFITTING INITIATIVES OF EXISTING BUILDINGS TOWARDS ENERGY REDUCTION

Nur IzieAdiana Abidin, Rozana Binti Zakaria, Safrin Rifaya Gulam Dasthagir

1.1 INTRODUCTION

Buildings play a crucial role in creating work and living spaces that contribute to national economic development, modernization, and urbanization achievement [1]. However, sustainability issues on buildings have become a global concern as they account for almost 40 percent of the total annual world energy consumption [2]. Besides, buildings are also becoming the most important sector for the end-use of energy consumption [3]. Therefore, most countries concentrate on the construction industry, with high expectations of reducing carbon dioxide (CO^2) emissions [4]. Although the construction of new buildings is one of the sustainable development initiatives to meet the energy challenges, the idea of retrofitting the existing building is not being explored extensively [5]. Masrom et al. (2017) [6] had mentioned that the country is mainly concerned with the development of new sustainable buildings rather than retrofitting the existing buildings, which indicate by their low Green Building Index (GBI) rating [5].

However, retrofitting existing buildings has been recommended to achieve energy efficiency (EE) due to higher demand for energy, limited availability of fossil fuels, and the ecological impacts due to higher fuel usage. Hence, retrofitting a building is an opportunity to achieve energy savings and reduce carbon emissions. While most of the current buildings were not designed as energy-efficient

Therefore, the steps, theoretical and conceptual framework developed in the study help guide in the decision-making phase and during the selection of retrofitting initiative measures. Besides enhancing EE in the existing building, retrofitting also helps generate energy by using a renewable energy source. Furthermore, the conceptual framework provides more detail guidelines consisting of various criteria that can be considered to ensure the most efficient and satisfying results in retrofitting projects.

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CHAPTER 2
GREEN BUILDING AND ENERGY RETROFITTING

Monh Neardey, Eeydzah Aminudin, Rosli Mohamad Zin, Rozana Zakaria

2.1 INTRODUCTION

UN Climate Change (UNCC) has urged the need to reduce emissions due to increasing two-thirds of the global population by 2050. The expectation of a vulnerable large number of populations opens up improving the energy-saving mainly buildings and transportations sector. Green Building awareness has played a significant role in helping the cities leapfrog to a sustainable and green development pathway. Since 2015 the Green Building concept has been introduced to Malaysia to support the Sustainable Development Goal (SDG's) initiatives. One of the most important green buildings is achieving sustainable development in environmental protection and improving human life quality [1]. Based on the sources, the construction industry generates the most significant impact on the environment than other sectors. One of the mechanisms is green building designs and a standard to reduce energy consumption in building operation as energy efficiency in building [2]. Green building is one of the measures to mitigate significant impacts of the building stock on the environment, society, and economy [3]. One of the Green building explanations stated that green building had been used as a term identical to sustainable building and high-performance building. Furthermore, there are four pillars in encouraging green buildings, i.e., enhancing occupants' health conditions, minimizing impacts on the environment, local community, and the life cycle consideration during the planning and development process and the return on investment to developers [4][5].

building fabric and other advanced technologies such as air tightness, window shading, etc.

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CHAPTER 3
BUILDING ENERGY SIMULATION FOR RETROFITTING

Monh Neardey, Eeydzah Aminudin, Rosli Mohamad Zin, Rozana Zakaria

3.1 INTRODUCTION

The awareness of Green building becomes more vital and crucial across the nation. The Green Building concept has been introduced to Malaysia for implementation of the sustainable development goal. In terms of environmental protection and improving human life quality, green building has an essential role in achieving sustainable development [1]. Based on the sources, the construction industry generates the greatest impact on the environmental compared to other industries. One of the mechanisms is going to develop a standard to reduce energy consumption in building operation as energy efficiency in building and green building designs [2]. Green building is one of measures been put forward to mitigate significant impacts of the building stock on the environment, society and economy [3]. Green building has been used as a term identical to sustainable building and high-performance building defined as green building. Other study pointed out that there are four pillars of green buildings, i.e. enhancing occupants' health conditions, minimization of impacts on the environment, local community and the life cycle consideration during the planning and development process and the return on investment to developers [4][5].

To facilitate green building developments, there are various green building rating systems have been developed. There are various aspects of sustainability covering the structure of these green building assessment tools [3]. [6] In terms of cost and economic to performed the case study for ranking green building indicators, the result showed that among the total scores participants, energy efficiency contributes

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CHAPTER 4
EMPLOYING RETROFITTING STRATEGIES IN EVALUATING PROTOTYPE DESIGN IN EDUCATIONAL BUILDINGS

Mariya Aminu Kabir, Ibrahim Abubakar Alkali, Haifa Youssef Hamdoun Muhammed Gambo Abdullahi & Yakubu Aminu Dodo

4.1 INTRODUCTION

Prototype in architecture is a term used to define the reuse of a building type or building design. Prototypes have acquired certain prominence and visibility in recent times [1]. The idea of prototyping in architecture has been in existence for a while but until recently, it has been used primarily to test and refine elements of buildings, mainly during construction or the aesthetics. Currently, built prototypes are used to enhance environmental performance and reduce risks which translate into reducing cost.

Prototype designs have widely been adapted under residential buildings but recently, educational buildings have started adapting the trend also. It has been adapted mostly in primary and secondary schools because of their similarities. All stages of education from primary to secondary, use basic spaces, including classrooms, libraries, etc, making a design pattern that could be used to generate a prototype [2]. Although the functions may look the same, tertiary education requires more space to fulfill its function. These spaces may range between different fields being taught.

The prototype design is a common feature of buildings in Bayero University, Kano. It can be seen in many buildings in the university, for instance, the Centre for Renewable Energy and the Centre for Dry Land Agriculture, Faculty of

1. Prototype designs should be fully examined before adopting the design for a new building as the design's configuration may not be suitable for the uses/functions of the new building users.
2. Due to the peculiarities of each course/program undergone in universities, especially professional courses/programs where special requirements and equipments are needed, it is advised that these courses/programs are provided with facilities that are designed to suit the intended purpose of users.
3. The end users of the facilities, which are the students, should be included in the strategic planning for universities as relying on the BMAS alone, which was developed in this research is insufficient in achieving efficient learning facilities.
4. Policy makers should take into consideration the prospect for growth in the design of learning facilities as some new courses/programs tend to expand over time.

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CHAPTER 5
STRATEGIES FOR MITIGATING THE INFLUENCE OF MODERNISM TOWARDS SUSTAINABLE RETROFITTING OF HAUSA TRADITIONAL PALACES

Bilkisu Tahir Mukhtar, Faizah Mohammed Bashir, Ogunbode Ezekiel Babatunde, Hannatu Abdullahi Idris, Hela Ahmad Gnaba, and Yakubu Aminu Dodo

5.1 INTRODUCTION

According to Denyer [1] the myth of darkest Africa is persistent, and there are recast many people who hardly accept that traditional buildings of the continent merit more than passing consideration. Traditional architecture has gradually been sidelined and more attention is given to modernized facilities which is the new trend noticed in society today.

Before colonialism and its attendant modifiers, there had been a traditional practice of ornamentation in Makuba and external mural paintings for external walls in Hausa land, particularly concerning palace architecture. This decoration is mainly an urban phenomenon associated with wealth and sophistication, and it is primarily based on relief and abstract with some inanimate object [2]. A particular form of decoration known as graffito is used in Hausa land in which different color wall plasters are laid in layers, and the design is made by scratching away upper layers. Denyer [1] pointed out that this decoration may imbue some magical or religious significance.

Hausa architecture and settlement's essential lies in a hierarchy of spaces from the smallest village to the largest city, from the humble residences to the most complex

royal distinction. It is in this context that palace art and ornamentation can be appreciated.

Unfortunately, Hausa land palaces are becoming part of the calamities of modern influence to what is known as an upgrade. An extensive literature on these palaces' current situation reveals the injury the cause by modern trend. The research, however, draws attention to careful consideration on how to retrofit them. Otherwise, the sustainable approach deployed nowadays, when viewed from conservation and preservation will be no longer sustainable because it comprises future generations meeting their architectural heritage. The research, however, succeeded in exploring strategies and measures to approach retrofitting of Hausa traditional palaces.

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CHAPTER 6
ATTITUDE TOWARDS ENERGY CONSUMPTION AND STRATEGIES TO ENCOURAGE ENERGY EFFICIENCY IN A BUILDING

Nur IzieAdiana Abidin, Nurul Noraziemah Binti Mohd Pauzi, Rozana Binti Zakaria, Safrin Rifaya Gulam Dasthagir

6.1 INTRODUCTION

According to the prediction of the global construction industry, an average growth of 3.6 per cent of construction output expected to foreseen annually from 2018 to 2022 [1]. This increases the demand for energy significantly as well as the emission of carbons as the impact. With growing concerns about the environment, such as climate change, it is necessary to implement energy-saving strategies in every building [2]. Various factors affected how the energy used in homes, such as electricity costs, household and building characteristics, access to the energy supply, environment, types, and efficiencies of appliances used, energy sources, and energy policies [3].

However, [4] reports that about 80% of the building's economic growth value for energy efficiency remains undiscovered, mainly because of non-technical pitfalls. Based on an [5] report, energy-consuming devices' efficient operation will produce higher energy savings, sometimes 15 percent or more of the current energy bills. Therefore, its either actively or passively, households decide on when and how to use their electrical appliances as their primary energy system [6].

Besides, several measures for Energy Efficiency have been prepared to create a healthier living environment for present and future generations. These approaches include,

As a recommendation for future research, the study shall be conducted to a wider range of occupants to obtain more accurate results. This include, occupants from ordinary office building without professionals from academic background in order to study their awareness to promote energy efficiency in the building.

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CHAPTER 7
REDUCING ENERGY CONSUMPTION AND IMPROVING OCCUPANT WELL-BEING OF AN OFFICE BUILDING THROUGH RETROFITTING

Zulai Jarmai Baba-Girei[1], Ahmad Usman Naibi, Femi Akinbogun, Muhammad Mustapha Gambo, and Yakubu Aminu Dodo

7.1 INTRODUCTION

Energy consumption in the built environment has become a significant element in sustainable development discourses because of its adverse environmental effects and a projected and continued rise in energy demand [1,2]. Studies by Abu-ghozalah (2007); Boussora (1990), and Mahgoub (2004)[3,4,5] have shown that high energy consumption in buildings tends to be more conspicuous in large or corporate buildings, although energy demand in buildings influenced by a matrix of complex interrelations between several variables relating to the building itself, the climatic environment, and other socio-economic factors, it has established that the occupancy phase (overall building's use period) accounts for the highest amounts of energy consumed in a building life-span.

Humans spend 90% of their time indoors [6]. Various studies have posited that indoor environmental quality (IEQ) in the workplace is critical for occupants' health and productivity, it is evident that building performance is very crucial for a sustainable environment and occupant environmental comfort and well-being. This also has extensively pushed for the growth of various environmental designs and technologies in the quest for high building performance. Furthermore, the lack of understanding of how the building environment affects humans could negate performance and compromise occupant's environmental comfort and satisfaction.

adequate illumination, ventilation, and thermal comfort of the occupants.

The study has limited its focus to enhancing the building envelope, provision of energy-saving lighting and cooling systems, conservation of water, improved daylighting in the working environment, thermal comfort and improved well-being of occupants. The comparison presented above on before and after retrofit has indicated a huge 40% saving on energy consumption by retrofitting energy-saving light bulbs and air conditioners, provision of additional windows for enhanced daylight and ventilation, as well as improvement on the well-being of occupants by creating conducive conveniences, good illumination, and natural ventilation. There is the need to however monitor long term energy audit of the building which will give a more comprehensive performance of the building. This can act as a starting point for the Nigerian building professional to consider sustainable retrofitting as a strategy for retrofitting buildings.

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CHAPTER 8
EFFECT OF COOL PAINT APPLICATION TO THE INDOOR TEMPERATURE OF STUDENT HOSTEL ROOM IN UTM RESIDENTIAL COLLEGE

Nur Adleen Fitriyana Binti Azman, Rozana Binti Zakaria, Nur Izie Adiana Abidin, Safrin Rifaya Gulam Dasthagir

8.1 INTRODUCTION

Malaysia is an immensely developing country to offset its population growth and industrialization. Consequently, the natural landscape has been replaced with concrete jungle, which causes a rise in the earth's temperature due to development in urban areas. Moreover, the frequency and intensity of heat have been increasing gradually, and the value is expected to be more severe over time [1]. These have some alarming impacts both to human beings and the earth and its populace. The quantity of building construction has been increasing to adapt to the growing population, resulting in much heat production. At the same time, causing thermal discomfort for occupants in a building that eventually demands higher energy consumption [2]. Furthermore, the rising temperature has a huge impact of increasing the cooling demand hence the cost of giving comfort to the users both in business or private structures.

Today, buildings are designed in such a way as to provide thermal comfort to their occupants. The warmth island effect is a condition wherein the downtown areas' temperature is higher than surrounding rural zones [3]. Some factors causing this phenomenon of high density and sunlight retaining structures, utilization of heat absorbing materials, absence of green spaces and the creation of anthropogenic heat [4].

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CHAPTER 9
PASSIVE DESIGN APPROACH TOWARDS ENERGY-EFFICIENT BUILDING ENVELOPE FOR INDIVIDUAL RESIDENTIAL

Fathihah Ahmad Shah, Rozana Binti Zakaria, Nur Izie Adiana Abidin, Safrin Rifaya Gulam Dasthagir

9.1 INTRODUCTION

Energy issues are becoming a primary concern due to the depletion of non-renewable energy sources and increased carbon emissions. Growing population and rising standard of living among the residents have become the major factors leading to energy deficiency [1]. Besides, the imbalance of the carbon cycle due to electricity generation from burning fossil fuels eventually increases carbon emissions to the environment. Therefore, innovative approaches to chop down energy utilization and increasing renewable energy sources are fundamental to accomplish the energy efficiency goal. The Malaysian government expressed enthusiasm for the more prominent usage of green structures because of the current situations where energy consumption is in a huge demand [2]. Based on the above information, Malaysia has a solid requirement for, and incredible potential to apply, energy effective techniques in bringing down energy utilization in buildings by reducing energy usage for space cooling in buildings.

Building envelope systems are an essential aspect of private buildings. If energy efficiency is followed and manageable technologies are applied to the building envelope [3], more than 40% of energy consumption of the Malaysian buildings can be reduced. Various factors such as occupant comfort, productivity, energy use and running costs, strength, stability, durability, fire resistance, and aesthetic appeal of the building

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