ENERGY CONSERVATION OPPORTUNITIES IN MALAYSIAN UNIVERSITIES

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Abstract

The Ministry of Education Malaysia has urged all education centres to conserve energy. Energy wastage tends to occur in Malaysian universities mainly due to inefficient use of energy and lack of awareness among building users. In this context, energy conservation should be implemented to optimize energy use. This paper discusses the concept of a sustainable university with a view to propose some steps to conserve energy and achieve sustainability. Review of literature reveals that energy conservation methods can be classified into two categories: structural and non-structural. Within the context of these two categories, five high-impact energy conservation methods are suggested, including renewable energy, improvement of energy efficiency, energy usage management and monitoring, promotion and integration of energy concept, improvement on energy-saving awareness and energy-use behaviour. Based on the recommendations in this paper, Malaysian universities can adopt energy conservation methods that can be in harmony with their policies and strategies.

Keywords: Energy conservation, structural and non-structural energy conservation methods, sustainable university.

1.0 INTRODUCTION

Sustainability is an idealized societal state where people can live long, comfortable, productive, without compromising their needs. Such understanding is a concept originated from the Brundtland Report (1987), that sustainable development is "a process that aims at meeting the needs of the present generation without harming the ability of future generations to meet their needs". It enables human beings to do the same now as well as in the distant future. The concept of 'sustainability' has been widely promoted, integrated and considered in many sectors, including private, government, as well as education (Prugh *et al.*, 2000).

Malaysia is confronted with tremendous challenges in ensuring sustainable development (Aini Mat Said *et al.*, 2003). But, Malaysians have shown positive attitudes towards environmental and project sustainability through the initiatives undertaken by the government and others. Malaysian Universities will not be exceptions. However, creating sustainable universities in Malaysia is still at a pioneering and infancy stage (Nazirah Zainul Abidin, 2009). In fact, campus sustainability initiatives are being constrained by a numbers of barriers, including low priority of environmental issues on the campus, and lack of coordination between and

among advocates and key constituencies (Sohif Mat *et al.* , 2009)

Many universities have taken initiatives to create sustainable environment through various projects and research activities. Nevertheless, misunderstanding the concept of sustainability and not good planning has made such projects a failure. Hence, there is need for the concept of sustainability to be well understood by university's stakeholders before any sustainability projects are undertaken.

This article discusses sustainable university concept and its models, which are introduced by eternal expert to university. The discussion, however, is focused on interest and methods specific to 'energy conservation'. The purpose of discussion is to identify 'energy conservation' methods suitable for being used in a university. Two methods are singled out, namely 'structural energy conservation method' and 'non-structural energy conservation method', which will be discussed below.

2.0 THE CONCEPT OF SUSTAINABLE UNIVERSITY

University is a place of knowledge, where ideas are generated, transferred, and creative solutions are offered. It is a place of targeting local and global communities. It is this notion that compels us to identify university campus as a place for that needs to achieve sustainable energy conservation.

A sustainable university is defined by the Velazquez *et al.* (2005), as:

"A higher educational institution, in its entirety or part, that addresses, involved and introduce, on a regional or a global level, minimize of negative environment, economy, social, and health effects generated in their resource utilization in order to complete to its functions teaching, research, outreach and partnership, and inside supervision ways to help society make the transfer for sustainable lifestyle"

The definition could be better understood if we relate it to sustainable university's activities. The Association of University Leaders for a Sustainable Future (ULSF) (1999) has clarified sustainable activities in a university, as those which are "ecologically sound, socially just, economically viable and humane", and able to "continue to be so for future generations". Basically, universities can achieve and contribute to sustainable development in many ways, including management, planning, community service, design**,** new construction, renovation, retrofit, and others.

In a achieving a sustainable campus, thus far, several suggestions are made. Among others, *The Sustainable University Classification Model* (Weenen, 2000) and *Frameworks for Sustainability University Model* (Clarke *et al.*, 2009) are noteworthy. The *Sustainable University Model*, developed by Velazquez *et al.* (2005) through point of reference for making comparisons the best practices with 80 different universities around the world, is explored in this article (*see* Figure 1). This model consists of four stages that are integrated into a plan-do-check-act (PDCA) framework. The first stage of the PDCA is identification of problems of unsustainability and generation of ideas to solve the problems (PLAN). Then, stakeholders have to evaluate a small-scale proposal for cost saving (DO). Next, they conduct review to determine whether the proposal achieves the desired result (CHECK). The final stage is the implementation of the proposed plan to resolve the problem as well as to enhance the quality and efficiency (ACT). However, the model does not stop at this stage, it requires running the process recurrently and routinely, from the beginning to the end of the above four stages, to find and resolve new challenges for continuous improvement in campus sustainability. This model has four strategies for sustainability initiatives at universities, namely education, research, outreach and partnership, and sustainability on campus.

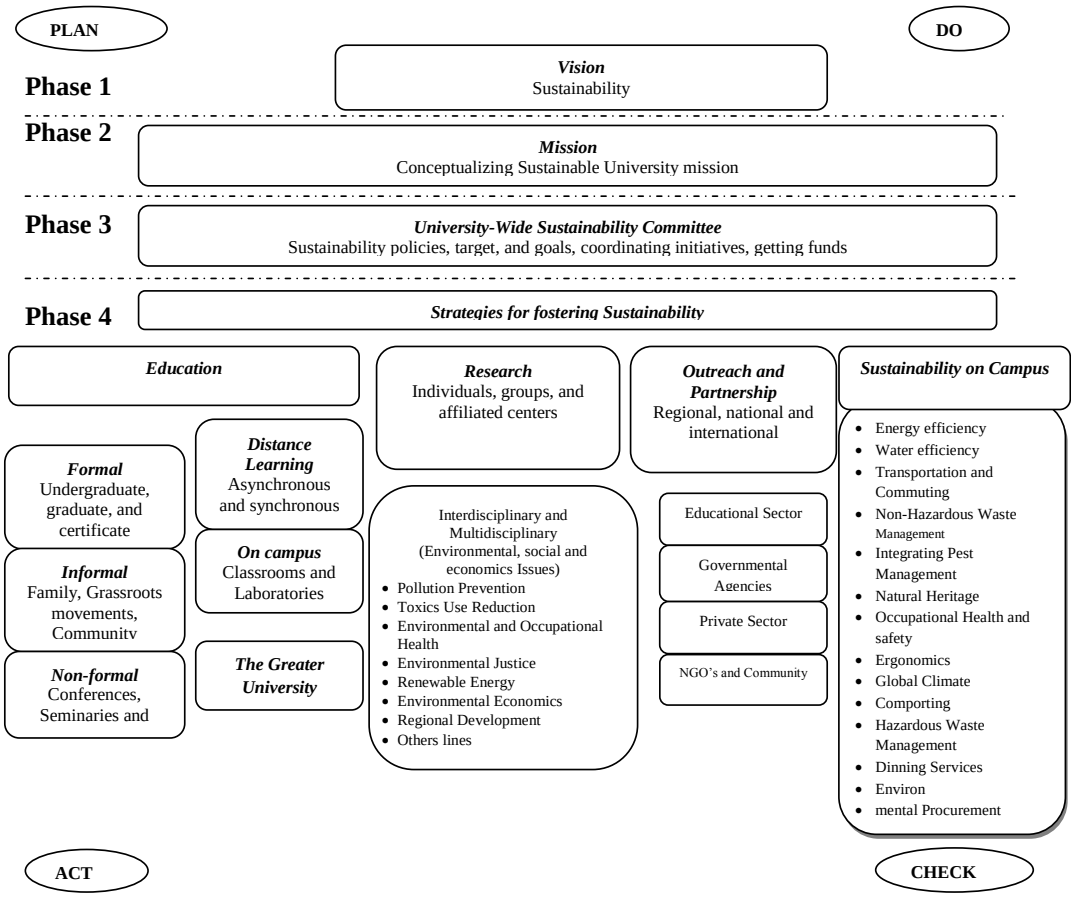

Figure 1: The proposed sustainable university model.
Source: Velazquez *et al.* (2006)

University stakeholders need to understand the three elements of sustainable development i.e., environment, social and economic. These three elements are integrated with each other (*see* Figure 2). Blackburn (2007) has suggested that metrics for Sustainable University should include these three aspects, namely environment performance, social performance and economic performance. Commitment towards these three basic elements is essential if the university has set its aspiration in achieving sustainable status. Table 1, Table 2 and Table 3 have listed out some outstanding commitments from various foreign universities towards these three elements. They could serve as example for Malaysian universities that intend to make their campuses sustainable.

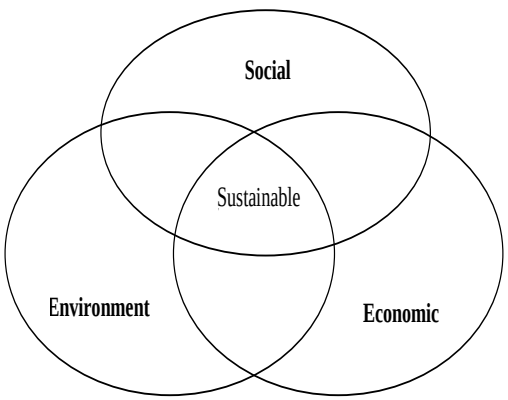

Figure 2: Sustainability across the Curriculum
Source: World Commission on Environment and Development (1987)

Table 1: Commitments of select universities towards sustainability

Name of University	Commitments
Environmental Sustainability	
University of Bordeaux	• Management of natural resources, including energy and water use are based on a "laissez-faire" policy • Water conservation program in the university is supported by Regional Water Utility Agency
Francis Marion University	• Installation of efficient lighting system in gymnasium and conduct paper recycling program.
The University of Edinburgh Estates & Buildings Department	• Establishment of environmental friendly policies code of practices guidance notes and specifications. Among policies that they introduce are Sustainability Policy 2000, Environmental Policy 1993, Waste Reduction Policy 2005, Integrated Travel Policy 2000 and Utilities Policy 2003.
Dalhousie University	• Adoption of an environmental policy in 1990, which includes contents on operation, education and research. Many initiatives are focused on the areas of solid waste, hazardous waste, toxins, air quality, energy conservation, and environmental education
Social Sustainability	
Technical University of Catalonia	• Technical University of Catalonia (UPC) Environment Plan is according to 41 action projects within the framework of the five natural areas of the University such as undergraduate education, postgraduate education, research, university life and awareness raising.
University of Hertfordshire	• Development of a Sustainable Development Policy • Promoting awareness among students regarding the environmental impacts on their studies and cooperation interdisciplinary research on sustainable development themes. • Best practices for the university as well as the local community to participate in sustainable development.
Aalborg University	• All first-year students in Engineering and Science attend a course in Technology, Human Beings and Society, dealing with some of the notions of sustainability. • The majority of teachings in sustainable development and related environmental issues is undertaken by the Division of Technology, Environment and Society in the Department of Development and Planning.
Clemson, Medical University of South Carolina and University of South Carolina	• Students' organization introduce of seminars and presentations, as well as volunteer projects to clean up campus or nearby waterways, plant trees and involved in other environmental activities during Earth Day.
Economical Sustainability	
St Petersburg State University	• A project, in the Russian Science Academy, was conducted aiming to provide energy saving solutions for academic institutions. In an early evaluation of the project, it achieved 15 percent reduction in energy budget. Other academic institutions such as Lebedeve Physical Institute and Baikov Metallurggy Institute also benefited from this project.

***Source**:* Compilation from University of Hertfordshire (1995); Barnes and Jerman (2001); Capdevila *et.al* (2001); Bonnet *et al.* (2002); Verbitskaya *et al.* (2002); Pike *et al.* (2003); The University of Edinburgh (2004); Clarke (2006);Christensen *et al.* (2009).

The rationale of the sustainable campus is to become more efficient in resources use, particularly in energy usage. Among many listed activities, energy conservation can be one of the effective tools in assisting Malaysian universities to achieve sustainable status. In fact, the integration and promotion of energy conservation concept in the university can reduce energy usage and minimize carbon footprint. Sohif Mat *et al.* (2009) explains that the energy efficiency can increase the lighting performance, keep comfortable temperature, reduce the high cost of electric power, minimise dependence on electricity, and improved ventilation and indoor air quality. Choong *et al.* (2009) has justified energy conservation in Malaysian universities on ground that they have large number of building users and enormous facilities such as classrooms, offices, libraries, etc. Also, universities are education centres, therefore, training on energy saving can be easily implemented among student and staffs.

3.0 SIGNIFICANCE OF CONSERVING ENERGY

Energy is the capacity of a physical system to perform work (Hall and Hinman, 1983). Cutler and Christopher (2006) defines energy conservation as:

'A collective term for activities that reduce end-use demand for energy by reducing the service demanded, e.g., a reducing the number of miles driven, or a reduction in the demand for natural gas for space heating by lowering the thermostat'

Energy has become one of the essential inputs for social and economic development and a basic need in our modern life and contributes to nation's growth and development (Energy Policy of Malaysia, 2005).

Goldemberg et.al, (2000) has stated that the production and use of energy should not endanger the quality of life of creatures and be able to help in the ecosystems. Since the oil crisis in the 1970s, energy conservation and security of energy supply has become a global concern (Gardner & Stem, 2002).

Since 2007, The Malaysia Ministry of Education has urged all education centres to save energy (The Star, September 13, 2007). Administrators in Malaysian universities also are concerned about the expensive monthly electricity bill. Both energy managers from Universtiti Teknologi Malaysia (UTM) and International Islamic University Malaysia (IIUM) have agreed that local university nowadays are facing serious energy wastage problems. Energy cost them more than ten million ringgit annually and this burdens the universities (Choong et.al., 2009). This leads to a new thinking and search for new methods of conserving energy that need to be studied and used in order to save costs.

4.0 ENERGY CONSERVATION METHODS

Behavioural approach and technology approach are two common ways in energy management (Mohon et.al., 1983). These two approaches are also known as structural and non-structural conservation methods. Al-Mofleh *et al*., (2009) explains the two methods in electrical energy conservation in Malaysia by the integration of three measures: use of efficient electrical equipment; application of passive energy technology in buildings, such as insulation, evaporative cooling, ventilation and solar heating; and supporting tools such as public awareness, energy codes, regulations, energy information and databases. The use of efficient electrical equipment and application of passive technology in buildings are categorized as structural energy management whereas public awareness, energy codes, regulation and other supporting elements are termed as non-structural energy conservation measures.

The energy conservation opportunities in Malaysian Universities need to be investigated in the context of both the structural and non-structural energy conservation methods.

5.0 STRUCTURAL ENERGY CONSERVATION METHOD

Structural energy conservation method refers to technology fixation. Technology fixation is a process whereby instrument, tools or technology are used to conserve energy. These include the introduction of new process, change to automation systems, or installation of large energy-saving devices, such as heat recovery systems, new building designs, inverter, pre-heater, motion sensor, building envelope systems, and others. Basically, the structural energy conservation method can be further divided into three types namely renewable energy generating technology; energy efficiency improvement technology; and technology for managing and monitoring energy usage.

5.1 Renewable Energy

The largest non-renewable energy resources found in Malaysia are fossil fuels and natural gas, which is being actively exploited. There are also potential renewable energy sources in Malaysia, most of which is biomass and solar. Biomass requires the available of palm oil and bio waste to serve as the input for generating electricity whereas the solar using Photovoltaic (PV) technology to harness the power of sunshine to supply electricity (Snyder and Bonta., 2008). Among the two, the solar energy is more convenient to be utilized in Malaysian universities since it makes use of renewable energy directly from sun. It is possible and beneficial to implement the solar panel system to power electrical appliances in Malaysian university as they receive abundant of sunshine throughout the year. It is said that most of electrical appliances that run with utility-supplied power theoretically can be powered by solar power (Snyder and Bonta., 2008). This can significantly reduce university electricity cost. Also, the benefits of installing solar penal come in many ways: it is reliable and virtually maintenance free; it does not produce greenhouse gases, and above all, it is renewable as long as the sun keeps shining.

5.2 Improvement of Energy Efficiency

'Energy efficiency is a reduction in the quantity of energy used per unit service provided' (Cutler and Christopher, 2006). The two major systems providing common building services are: (1) Heating, Ventilation and Air conditioning (HVAC) system, and (2) lighting system. Appropriate measures and improvement can help in efficient energy consumption.

HVAC is the most common system throughout Malaysian universities. With HVAC system, electricity is used to generate cooling air for lowering room-temperature. The efficiency of HVAC system can be improved through two structural approaches: (a) better HVAC control system and plant, and (b) better insulation.

HVAC control system is a computerized climate control system for indoor environment. Basically, the system uses central controllers to monitor remote terminal unit. The latest system allows remote access from a web browser indeed. Since many existing HVAC systems are manually operated, adapting remotely operated HVAC control system, by local universities, can assure better energy efficiency. Besides, Malaysian Universities should take initiative to upgrade their HVAC plants. This can be achieved through installation of smaller and more efficient heating and cooling equipments to match the building's operating load (Lancashire, 2004). The size of an appropriate HVAC plant can be determined after detail energy audit.

Building insulation is the method of preventing heat or cold air from escaping and entering the building. In order to increase the effectiveness of any hot or cold system, one can adopt the use of insulation into a particular system (Javier & Micheal, 2006). Heat and cool air is transferred from one material to another by conduction, convention and/or radiation. Insulators are used to minimize the transfer of such energy. Insulation is an important common element to improve energy efficiency in Malaysian buildings that uses a large proportion of total monthly energy consumption. A building such as a lecture hall should be well insulated as it

can save on the monthly electrical bills by reducing the cooling air generated by the air conditioning system from flowing to outside. Besides, insulation does not require complicated maintenance, upkeep, or adjustment.

Besides cooling, another common building service in Malaysian Universities is lighting. A well-designed lighting system should attain the desired lighting performance such as light levels and colour quality by using energy-efficient means. Nowadays, technological advances, such as electronic ballasts and compact fluorescent lamps, have increased the energy efficiency of lighting components. By introducing relevant technology, such as lighting control system that integrates with the HVAC system, the energy efficiency of the overall system could be increased. Another energy saving method, in this context, is the upgrade of the interior and exterior lighting, by using high-efficiency bulbs and ballasts, including replace of incandescent light bulb to fluorescent light. As fluorescent bulb produces less heat, i.e. 50 and 100 lumens per watt, it is four to six times efficient than incandescent bulbs.

5.3 Energy Usage Management and Monitoring

One of the simplest and most effective methods of conserving energy is to operate equipment whenever it is needed. Energy savings can be achieved without affecting occupant comfort by turning the equipment off (Thumann, 1985). Best still, the equipment can be switched off automatically when there is no one using it. Energy consumption can be monitored and managed properly through tools such as motion sensor, Building Energy Management System (BEMS) and Computer Aided Facilities Management (CAFM).

Motion sensor can be used for many purposes in university, including security and energy savings. A sensor automatically turns lights on when movement is detected and off when movement stops. Universiti Teknologi Malaysia has taken initiatives to install motion sensors in some of its toilets. The lighting will turn on automatically when they sensed movement in the toilets. This would definitely reduce unnecessary energy cost.

Building Energy Management System (BEMS) is a microcomputer systems used for controlling and monitoring building services plant (Levermore, 2000). Also, it can be implemented for monitoring other building's electronic appliances. BEMS system can also be used for better energy monitoring and saving. Several institutions have invested in building energy management systems (BEMS) to control and monitor the building's temperatures. The results reveal that it can reduce energy-use, up to 20 percent (Creighton, 1999).

On the other hand, Computer Aided Facilities Management (CAFM) is a combination of Computer-Aided Design (CAD) or relational database software with specific functions to manage facilities. The CAFM can assist facility manager to plan, monitor and review the facilities management process. Although CAFM differ from BEMS, both of them, however, could be integrated for better energy performance. The tasks can be performed by the CAFM querying the BEMS, or by a form of integration (Elmualim, 2009). Different types of CAFM system are currently available in the market, including *Archibus* and *Maximo*. Universities may select any of them, based on their suitability and cost.

6.0 NON-STRUCTURAL ENERGY CONSERVATION METHOD

A sustainable future cannot be secured by relying only on the structural energy conservation methods. The non-structural energy conservation method must be taken into consideration as well. Non-structural energy conservation includes integrating energy conservation concept in the management and co-curriculum of universities, and improving energy awareness and energy use-behaviour among users.

6.1 Promotion and Integration of Energy Conservation Concept

In order to foster "energy concern" among students, university's management should integrate environmental subjects into the co-curriculum by offering the relevant subjects or activities to include energy issues, energy conservation techniques, as well as benefits gained from energy conservation. Many conferences, seminars, and workshops on energy should also be conducted from time to time.

The Ninth Malaysian Plan has stressed that energy sector will continue to focus on sustainable development to support economic growth, enhance competitiveness as well as contribute towards achieving a balanced development. In line with the national interest, energy conservation can be achieved through proper university's energy policy. The university's energy policy should embrace all three fundamental concepts of sustainability: environmental, economical, and social. In addition, it should also create an understanding among campus community about the importance of energy conservation. A good energy policy will cover the interest of the energy conservation stakeholders as well as those of users. In the context of stakeholders, it may allow energy managers to participate in business and facility planning, selection and purchase of energy efficiency equipment, and conducting training. For users, the university may set regulation such as to forbid students from using rice cooker, televisions, refrigerator and other high current electronic appliances in hostel. Penalties can be imposed to enforce such a policy.

6.2 Improvement of Energy Awareness and Energy Use-Behaviour

'Behaviour' is defined as "the totality of intra and extra organism actions and interactions of an organism with its physical and social environment (Wolman, 1973)." In terms of behavioural approach, attitudes, knowledge, awareness, and skills can tremendously help in energy conservation (Vesma, 2002)." The behavioural approach can enhance energy conservation by encouraging and persuading building users to conserve energy.

A Conceptual Model of Energy Awareness Development Process (CMEADP) was proposed by Choong (2009) to raise energy awareness and improve energy-use behaviour among students and staffs in university. The model was divided into eight phases that consisted of Assessment I: measurement of original behaviour, energy awareness stimulus, transference method; and assessment II: measurement of energy awareness, regulation of behaviour; assessment III: measurement of behavioural improvement, follow-up; and assessment IV: measurement of retention.

Malaysian universities may get the benefits from such model in creating energy awareness and improving energy-user behaviour. Energy awareness is an important criterion to achieve energy sustainability. Without energy awareness, effort in energy conservation can be difficult, which may lead to energy wastage. Attention must be paid by universities to creating awareness as an initial step in any energy conservation program.

7.0 CONCLUSION

In response to the call by the Ministry of Education Malaysia to save energy, it is important for Malaysian universities to completely understand the concept of sustainability and to commit themselves to energy conservation efforts. There are two methods in conserving energy namely structural and non-structural. The structural method includes using renewable energy, improvement of energy efficiency, as well as managing and monitoring energy usage. The non-structural method includes promotion and integration of energy conservation concept, raising energy awareness, and improving energy-use behaviour. Both methods, it is believed, can help Malaysian Universities contribute to energy conservation more effectively. However,

structural energy conservation method i.e., installing solar panels and CAFM system may seem too costly to university. Therefore, it is suggested that universities should begin with low budget energy conservation methods. This can be achieved through the non-structural energy conservation method, which can be used after an appropriate feasibility study is conducted.

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