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Developing Curricula for Energy and Environmental Course at Universiti Kuala Lumpur Malaysia France Institute (UniKL-MFI) through Knowledge Transfer Program

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Abstract

Depletion of global energy resources and global warming issues have been the theme topics of the world economic circle over the past decades. Looking at this scenario, it is essential to every sector including educational institution to play its role in engaging public and community at grass-roots level on these issues. Keeping the above factors in mind, a Knowledge Transfer Program (KTP) was carried out to transfer knowledge on curricula of energy and environment to a selected tertiary educational institution in Malaysia. The aim of this program was to link generated academic knowledge on energy and environment to targeted community or group as part of commitment to knowledge transfer. In order to achieve the aim, a partnership was formed between CETREE&GT and UniKL-MFI for two years with three main stages of program implementation comprising of: i) training on renewable energy and energy efficiency to graduate intern and technical support team; ii) selection of academic staff from the targeted community and; iii) a series of workshop. Two workshops were convened to develop and harmonize curricula of energy and environmental course and were followed by two more workshops to discuss, select and construct appropriate teaching aids and methods for the course. Design and development of the teaching aid were based on the model of an Energy Efficient Building by taking into account renewable energy and energy efficiency components such as solar energy, wind energy, biomass and thermal electric generator. With active involvement from university and community, in planning, executing, monitoring, control and closure, the program was successfully devised and managed. At the end of the program, a module of curricula for Energy and the Environment course and Energy Efficient Building teaching aid were developed. Through this program, contributions from both parties help to build committed societies to engage in important issues in relation to energy and environment towards creating a sustainable future.

Keywords: knowledge transfer program; energy and environment; curricula; module and teaching aid.

INTRODUCTION

This document Collaboration between Universiti Sains Malaysia (USM) and Universiti Kuala Lumpur Malaysia France Institute (UniKL-MFI) was set up to transfer the knowledge related to energy, inclusive of renewable energy and energy efficiency. The main objective of this project is to transfer the curriculum of Energy and the Environment course and Centre for Education and Training in Renewable Energy, Energy Efficiency and Green Technology (CETREE&GT), USM teaching aids to the community partner UniKL-MFI, and then to train and transfer the knowledge about energy and environment to lecturers and students of UniKL-MFI. The program was aimed to link the generated academic knowledge on energy and environment in USM to targeted community or group as part of commitment to knowledge transfer and sharing.

The work presented in this paper focused on developing the related energy and the environment course at UniKL-MFI and also considers the possibility of producing a teaching aid with four renewable energy sources of wind, solar, biomass and Thermal Electric Generator (TEG) to electrify an energy efficient green building model.

The teaching aid provides an automated artificial sun to operate a solar tracker on the roof top house model. The data acquisition and control were manipulated on a touch screen TV and connected to a web page PHP via internet. The web based monitoring uses Raspberry Pi 2 Model B with accessories router and network cable which allow control and data acquisition from a LAN (Local Area Network) or any internet connection display on lap top or Android smart phone. The demonstration system will be more interactive, with course notes slide presentation on Energy and the Environment provided and distant learning can be accessed on the web.

RELATED WORK

Environmental education program helps students understand that everything in their natural surroundings was interrelated and that there are limited amounts of substances and space in the world. In addition, students must realize that environmental problems have no simple answers and that they have both social and scientific implications. Students must obtain the skills necessary to work toward the solution of these problems. It is important for students to assume responsibility for the conditions they create and demonstrate consideration for the future in making environmental decisions. These criteria are also important in a good energy education. Not many are aware that our fossil fuel supplies have a limit. If we run short of available fuel resources and do not have an alternative energy supply, every aspect of our lives will be affected. Our food supply will be less abundant, transportation will be limited, our homes will be uncomfortable to live in, and the items we buy will be more expensive. What could better illustrate the concept that conditions in our social environment and in our natural environment are interdependent? As a consequence, the approach to energy education must be interdisciplinary since it deals concurrently with both social and scientific concepts.

Ideas about environmental education continued to evolve during the 1970s, and by 1977 when the world's first Intergovernmental Conference on Environmental Education was held in Tbilisi, Georgia, there was emerging agreement that environmental education had three main goals: i) to foster clear awareness of, and concern about, economic, social, political and ecological interdependence in urban and rural areas; ii) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; and iii) to create new patterns of behaviour of individuals, groups and society as a whole towards the environment (Annette and Brian, 2005).

Renewable energy academic programs rapidly grew in Malaysia public and private universities. This trend was the implication of world development on renewable energy program. New renewable energy concept developed due to industry and domestic demand. New demand on competent technical labour of installation, design and wiring bring universities to develop renewable energy academic program (Thomassian and Amani, 2010).

The basic practical knowledge is not delivered solely through teaching module with dozens of theoretical knowledge. Hence, educational training kit will help in practical knowledge and introduce a green technology based system to educate the student on electrical and green technology (Ranjit et al., 2010).

Universities usually developed their own renewable energy trainer kit to support renewable energy academic program funded from university and government grant. Some universities bought customised renewable trainer kit from commercial supplier for example EDIBON, Lab-Volt, De Lorenzo and Hampden (Condoor, 2011 and Wangpin et al., 2014).

METHODOLOGY

This project was implemented through several phases, comprising of:

1. Training the Graduate Intern on the knowledge of Renewable Energy and Energy Efficiency;
2. Selection of UniKL-MFI academic staff with background in Green Technology;
3. Workshop to fine tune the curriculum of Energy and the Environment course by selected academic staff of CETREE&GT and UniKL-MFI;
4. Workshop to fine tune the teaching aid of Energy and the Environmental course;
5. Final fine tuning workshop, printing of module and building teaching aid.

The program was initially facilitated through a formalised project plan as part of KTP model in which 19 academic staffs from UniKL-MFI having theoretical and technical background in green technology were selected. Then, a training workshop was conducted to build the capacity of team members of the programme in relation to information of renewable energy, energy efficiency and programme execution plan. Two workshops were convened to develop and harmonise curricula of energy and environmental course and were followed by two more workshops to discuss, select and construct appropriate teaching aids and methods for the course. Project members of USM and selected staffs of UniKL-MFI agreed to construct and design a teaching aid which implements the green building concept as shown in (Fig. 1).

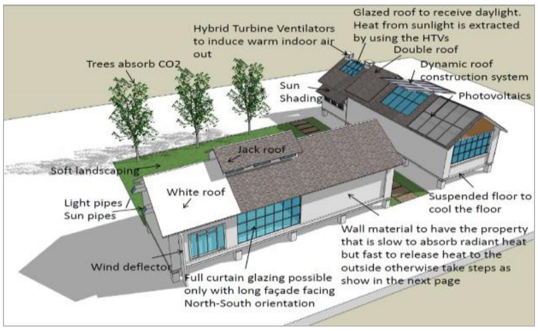

Figure 1: The design for an energy efficient green house

RESULT AND DISCUSSION

Through a series of workshops and discussion conducted, a module named Energy and the Environment was developed, consisting of 6 chapters: 1. Overview of Energy; 2. Environment; 3. Energy Policy in Malaysia; 4. Renewable Energy; 5. Energy Efficiency; and 6. Future Fuels, as shown in (Fig. 2). This module will be used as a reference to the elective course for students in UniKL-MFI.

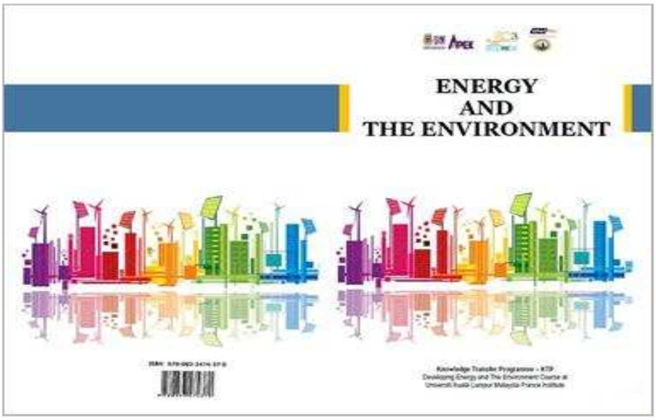

Figure 2: Energy and the environment module

Then, a teaching aid based on the model of an Energy Efficient Building was constructed, with additional hardware representing renewable energy sources, which can be controlled by web applications.

Components of Proposed Energy Efficient Building

Green Building Model

A green building starts with well designed, well insulated and well positioned to rely as much as possible on passive heating and cooling. An efficient and resilient home is one that uses minimal energy for heating, cooling, lighting and running of electrical appliances. The biggest factor in tropical countries is cooling. Reduce cooling will reduce emission of greenhouse gases. The design of the house with 70% of its windows facing north or south (passive cooling) reduced 30% energy consumption in the house. Another cooling method is to plant trees to provide shade to the house. Furthermore, applications of reflective material and white paint reduced radiant heat. A wind deflector placed under the house improved circulation of air movement. Table 1 shows the design planning and characterization of the energy efficient building.

Table 1: Design Planning and Characterization

SITE PLANNING	RATIONALE
Trees, vegetation & soft landscaping	-Absorb carbon dioxide and release of oxygen -Reduce Urban Heat Island (UHI) by absorbing heat
Water bodies	-Cools the building site environment by land & sea breeze phenomenon
Valley	-Prevailing valley winds at foothills
BUILDING DESIGN - Walls	RATIONALE
Sun orientation	-Long wall facing the North-South orientation as this will reduce the exposure of the wall area to sun impact which then absorb, retain heat during day time and then release heat during night time
Sun-shadings for openings at walls such as windows and/or curtain walls	-Prevent sunlight from entering the indoor environment otherwise it would heat up the indoor air which then requires air conditioning or fan to counter the heat built up thus consuming energy
White paint	-Assist in reflecting heat away from walls. This involves the knowledge on the Solar Reflective Index (SRI)
Double wall / Cavity wall	-There is an air gap between the outer wall and the inner wall. The air gap acts as an insulation preventing heat from the outer wall that absorbs the heat from direct sunlight.
Bio-facade / Green wall	-Plant growing vertically, providing shade along the external walls. This double up as an aesthetic function. Sometimes vegetable can be grown as vertical gardening. It also absorbs carbon dioxide
BUILDING DESIGN - Roof	RATIONALE
White paint	-Assist in reflecting heat away from the roof. White roof is most effective since it is totally exposed to the sun from morning until sunset because of the sun's movement in the tropical zone
Double roof – pitched or flat	-The air gap between the outer and inner roof acts as an insulation preventing heat from the outer roof which is exposed to direct sunlight.
Insulation	-Insulation foam for example coolbatts or rockwool located on top of ceiling. -Silver lining located along pitch of roof to reflect heat from roof finishes.
BUILDING DESIGN - Ground Floor	RATIONALE
Suspended on columns	-This prevents re-radiation of hot air from outside ground surface from entering the building interiors. Being elevated also captures a relatively faster air velocity for cross ventilation.
BUILDING DESIGN - Daylighting	RATIONALE

Building orientation	-North-South orientation. Full curtain glazing possible only with long façade to maximize daylighting -East-West orientation. If facing North South is not possible, façade facing East-West sun must be double glazed otherwise the 'greenhouse effect' takes place
Building interiors	-Highly recommended that walls, ceilings and floors to be of bright colors for good SRI

Power and Control Board

Fig. 3 shows the circuit board consisting of a variety of electronic components assembled to provide power and control system to operate power generation, ventilator spin, vertical axis wind turbine (VAWT) spin and artificial sun movement at the house.

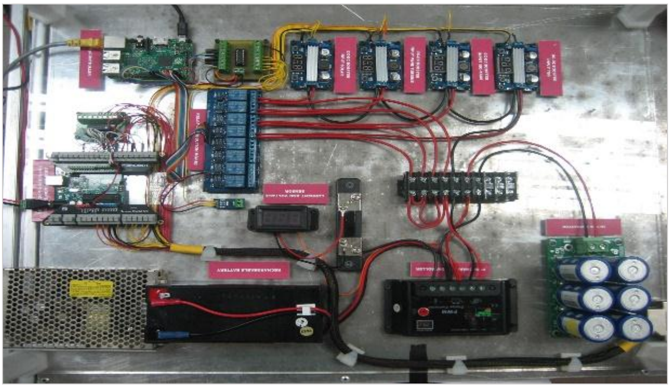

Figure 3: Complete controller board system

Solar Panel and Solar Tracker

Fig. 4 shows a set of 4 solar cells connected in series and parallel to form a solar module of size 80mm × 140mm, and mounted on top of the roof of the house model. The module was designed to supply electricity at a certain voltage. The current produced is directly dependent on how much light strikes the module. Solar tracking is an obvious way to improve the efficiency of solar power production. A servo motor ensures the solar module automatically follow and maintain the optimum angle as the sun moves in order to make the most of the irradiation light. A DC motor was used to move the sun model. Tracking the sun will increase the efficiency of the solar module up to 45%. 4 pieces of Light Dependent Resistor (LDR) were buried in the ground of the house model from east to west direction. These sensors controlled the solar tracker movement.

Figure 4: Solar panel and solar tracker attached on the roof of house model

Vertical Axis Wind Turbine

Fig. 5 shows a prototype of VAWT which was custom made using 3D printer. The design shape of this VAWT is superior in performance and efficiency compare to a horizontal axis wind turbine (HAWT) on a flat terrace. A 12 Volt DC motor was coupled to the VAWT to move the blade without the presence of wind, thus acted as a dummy demonstration for a wind turbine generator.

Figure 5: Vertical axis wind turbine custom made using 3D printer

Thermal Electric Generator (TEG)

TEG is a device which converts thermal energy directly into electrical energy due to the Seebeck Effect. TEG has high reliability, small size, compact, light, environmental friendly and long life. Fig. 6 shows the TEG12706 which was used as the power source generator in this prototype, with a size of 40mm × 40mm × 3.8mm and operated from -30°C to 138°C. The TEG structure consisted of a thermoelectric material sandwiched by two heat exchanger plates, the hot and cold sides. A current is produced when there is a temperature gradient in the thermoelectric material. Cooler Master was used to cool the cold side of the prototype. JetFlo 140 fan was applied to ensure the best radiator heat change efficiency.

Figure 6: Thermal electric generator module

Biomass

Fig. 7 shows a prototype of biomass (biogas) module which was modified based on a foreign steam engine toy product available in the market. An electric generator was installed next to the pulley, where belting was implemented. The orange pulley and the electric generator holder were created by 3D printer.The steam engine will rapidly extract and retract continuously when the tube vacuum is heated with a torch lighter, supposedly representing biogas supply. The generator will move accordingly and produce small electricity. A DC–DC booster will step up the voltage from 3V to 30V.

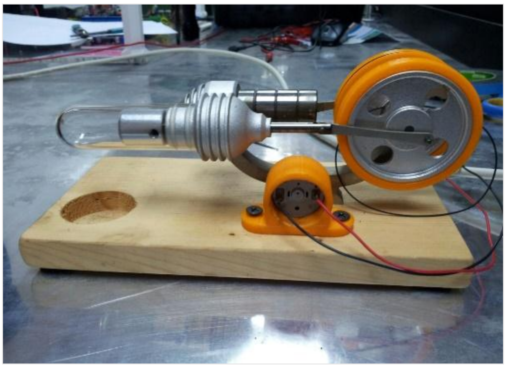

Figure 7: Biomass module

Artificial Sun

A spotlight of 400 Watt halogen bright natural white light with die cast aluminium housing was used to act as an artificial sun. A 240V AC supply was used to light up the lamp, which was tied and screwed to a linear motion rail to represent the sun movement. Fig. 8 and Fig. 9 show the artificial sun and its holder printed using 3D printer, respectively.

Figure 8: Spot light representing an artificial sun

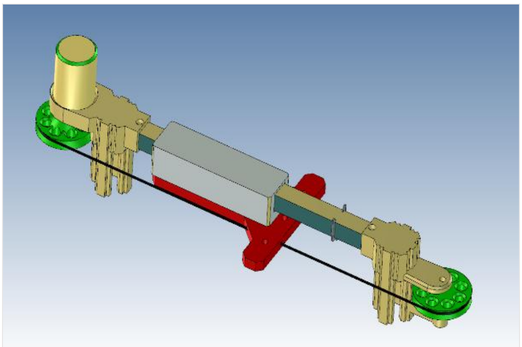

Figure 9: Artificial sun holder using 3D printer

Components of Proposed Web Based Application

Raspberry Pi 2 as Web Server

The Raspberry Pi 2 is a single board, low cost, low power computer system running on Linux or other operating system on an Advanced RISC Machines (ARM) microcontroller. The system boots from an 8 GB SD card. A power requirement of only 5 Volt is sufficient to run the system. The software is stable and has 40 General Purpose Input Output (GPIO) pins. The device is small yet with powerful performance. The Raspberry Pi acted as a web server by which motor and sensors can be controlled in LAN or Internet Connection. Arduino microcontroller was responsible for the current and voltage data collection which were then sent to Raspberry Pi. The current sensors were connected directly to the Arduino card (Suresh et al., 2014).

Web Application

The main system software used is the Raspbian build of Debian. This software is available as a free download from Raspberry Pi foundation and needs to be written to the SD card. The Raspberry Pi is scripted in Python to read current sensor and control Arduino before running as web server. The PHPMyAdmin software is installed and produced webpages which are served up by Apache. PHPMyAdmin sets up regular logging and produced graph over various time frames. Fig. 10 and Fig. 11 show the web page dashboard on control button and on graph, respectively.

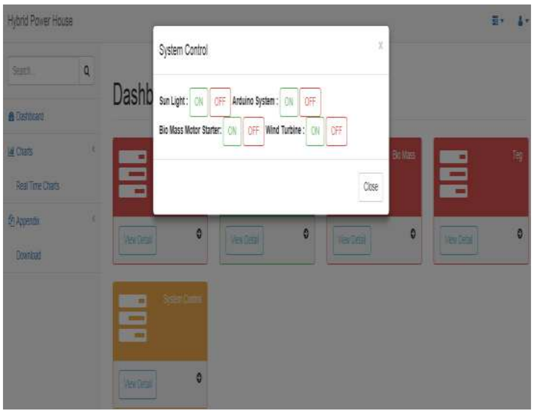

Figure 10: Web page dashboard display on control button

Figure 11: Web page dashboard display on graph

A block diagram of the proposed model of web based control system for the Energy Efficient Building and its renewable energy components is shown in Fig. 12.

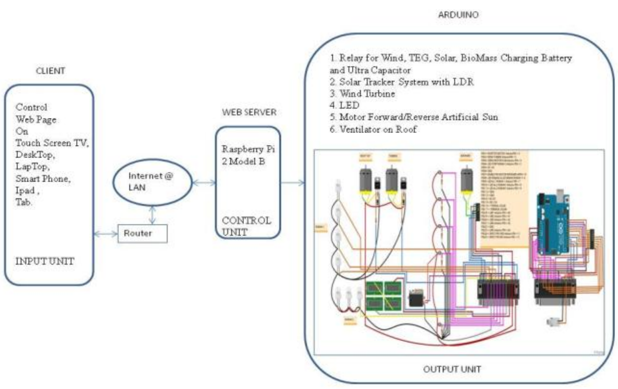

Figure 12: Block diagram of control system

The integration of an energy efficient building passive design, hardware representing renewable energy source and web application enabled the successful development of a teaching aid on Energy Efficient Building with four sources of renewable energy together with web based control and real time data acquisition. The teaching aid is able to support online teaching and learning, supervision and control within LAN and internet. Fig. 13 shows the completed Energy Efficient Building teaching aid system which is low cost, easy to maintain, portable and can be easily upgraded with additional components.

Figure 13: Energy efficient building teaching aid

CONCLUSION

Through the Energy and the Environment module, students are able to gain appropriate knowledge on energy resources, develop positive attitudes towards the environment and provide them with the opportunity to heighten awareness about natural, social, technological and historical environmental issues. The fabrication of an interactive education based on the Energy Efficient Building teaching aid will help staffs and students understand more on the practical side of energy efficiency and renewable energy.

The future plans of this knowledge transfer programme are to expand the knowledge related to energy and environment to other branches of UniKL and other interested higher education institutes, and to develop more teaching aids related to the course in order to assist teaching, learning and understanding. The model can further be improved and extended by adding more renewable energy sources such as DMFC (Direct Methanol Fuel Cell), upgrading the web page and applying total SCADA (Supervisory Control and Data Acquisition) to develop distant learning in UniKL-MFI.

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