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The Development of Energy Efficiency Estimation System (EEES) for Sustainable Development: A proposed Study

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Abstract

In the modern era of globalization, energy is regarded as something precious. Thus, energy efficiency (EE) and cost effectiveness are key factors in maintaining economic growth. EE also educates consumers on ways to use energy efficiently and therefore, reduces energy consumption. In Malaysia, domestic sector is the third largest contributor to energy usage. The purpose of this study is to review EE practices and applications in residential buildings in order to raise awareness on smart energy consumption. In the preliminary stage of this study, consumers estimate their monthly energy consumption of their electrical appliances by using Quality Function Deployment (QFD) approach. QFD approach focuses on consumers' opinion of electrical appliances good and beneficial functions. Selection of residence was made between medium and affordable cost residential areas in Johor. Databases for energy relating to electrical appliances were developed based on the data obtained from the relevant ministry and agencies such as KeTTHA, Energy Commission and TNB. Energy Efficiency Estimation System (EEES) is being developed to help consumers estimate the amount of energy being used daily, which will help consumers to use energy more efficiently. EE indirectly helps reduce the effect on environment especially the greenhouse gases. The promotion of EE and independence from the non-renewable energy source is important in ensuring a sustainable development.

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Keywords: Energy Efficiency (EE), Energy Consumption, Home Appliances, Sustainable Development

1. Introduction

The world is now facing an unprecedented energy challenge: even if all energy efficiency policies are implemented with grand success, global primary energy demand is expected to increase 35% by 2035. This would have a dramatic impact on energy costs and energy security, competition for resources, access

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to energy for societies' poorest people, economic growth and of course climate change [1]. The global expansion of renewable energy sources and future of electricity generation are much in the centre of the energy discussion. Improving EE and redesigning power generation must go hand in hand. According to the International Energy Agency (IEA), the share of global electricity supply provided by renewables could reach 30% by 2035. The remaining 70% will have to be met by conventional sources of energy. However, due to their finite supply, costs are expected to rise. Their impact is also climate-damaging.

2. Malaysian Scenario on Energy Issues

Shortage in the hydrocarbon fuel sources, energy preservation and stringent emission regulations are among formidable challenges faced by the worldwide industry. Having said that, petroleum is a finite source identified as major source of pollution in the ecosystem, particularly for its Carbon Dioxide (CO_2) emission. This gas creates an atmospheric greenhouse effect linked to the global warming and climate change. In Malaysia, the Ministry of Energy, Green Technology and Water (KeTTHA) is responsible in reducing the CO_2 emissions to 40% [2]. The Green Technology and Climate Change Council (MTHPI) is implementing green technology in order to reduce greenhouse effect on global warming and climate change.

Although Malaysian economic growth is rapid and their expansion fast, they still face challenges that influence their competitiveness. Current scenario in Malaysia depicts challenges in terms of supply and demand [3]. This is evidently shown in the 2010 and 2011 annual reports by the Department of Statistics (DoS) and the Economic Transformation Program (ETP) handbook. Malaysia's economy is expected to grow strongly over the outlook period with an annual average growth rate projected at 4.8%. The strongest growth will be from the industry (the manufacturing sector) and the services sectors, attributing 54 and 46% shares of total Gross Domestic Product (GDP) in 2030 respectively [4,5]. This will naturally cause a substantial growth in energy demand for the transport, commercial and residential sectors. Figure 1 shows the Gross Domestic Product and Population and Figure 2 shows final energy demand.

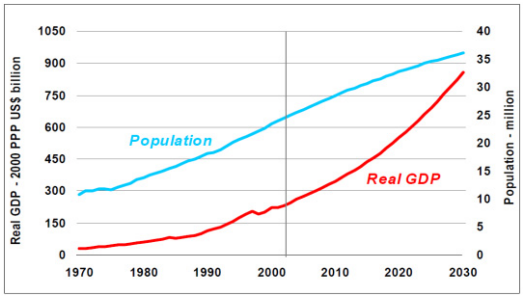

Fig. 1. Gross Domestic Product & Population

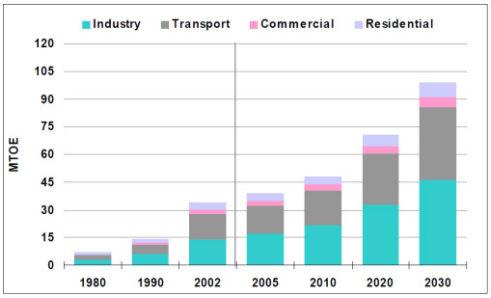

Fig. 2. Final Energy Demand

The electricity demand in Malaysia will increase by 4.7% per year over the outlook period, to reach 274 TWh in 2030. Electricity demand for the residential sector will also experience a strong growth of 4.9% per year due to improvement in living standards. Per capita electricity demand is projected to more than double from 2002 to reach 7,571 kWh/person in 2030, which is higher than APEC region average at 6,833 kWh/person. Malaysia has outlined its new economic development plan by introducing the ETP, which identified 12 areas known as National Key Economic Areas (NKEAs). Oil, gas and energy are grouped as one of the NKEAs. Under the Oil and Gas, 12 Entry Point Projects (EPP) are recorded, of which EPP 9 focuses on improving energy efficiency, under the sub cluster of building a sustainable

energy platform for growth. The industry is governed by KeTTHA and is regulated by the Energy Commission (EC) [6].

2.1. 12 Entry Point Project (EPP) of Oil, Gas and Energy

To ensure continuous supply of energy, the Government and the energy producers will focus on four thrusts: sustainable oil and gas production, enhancing downstream growth, making Malaysia the number one Asian hub for oilfield services and building a sustainable energy platform for growth. Table 1 below shows the 12 EPPs for oil, gas and energy sector.

Table 1. EPP for Oil, Gas and Energy Sector

BUILDING A SUSTAINABLE ENERGY PLATFORM FOR GROWTH	
EPP 9:	**IMPROVING ENERGY EFFICIENCY**
EPP 10:	Building up solar power capacity;
EPP 11:	Deploying nuclear energy for power generation; and
EPP 12:	Tapping Malaysia's hydroelectricity potential.

Energy issues are among the agenda discussed in the 10th Malaysia Plan. The development of alternative energy sources by 2015 is one of major initiatives in the 10th Malaysian [3]. Five strategic pillars of the new energy policy were presented under supply, utilization and environmental issue. The Residential, industrial, commercial and transport sectors are highlighted in EE discussions. Figure 3 below shows the five pillars in the new energy policy of the 10th Malaysia Plan.

In its effort to further enhance the performance of the energy supply industry, on 1st May 2001, the Malaysian Government established the EC under the Energy Commission Act 2001. The energy sector in Malaysia has undergone significant changes since the 1990. This was driven by the Government's aim to enhance security of supply, improve efficiency and quality in electricity industry and increase private sectors' participation in infrastructure development. To ensure that energy consumption is efficient and safe, the Energy Commission has launched a widespread awareness campaign through mass media [6].

According to Annual Report by EC in 2013, in carrying out its regulatory economics, the Energy Commission has developed a regulatory framework based on incentives that determines electricity tariffs in the peninsular. EC increased electricity tariff for the peninsular of Malaysia, to be enforced on 1st January 2014. The EC has also reviewed electricity tariff in Sabah and the Federal territory of Labuan. All three new tariffs were announced on 2nd December 2013. Despite the strategic recovery method that it provides for TNB, the increased electricity tariff is a burdensome to consumers. What consumers have to do is to familiarize themselves with EE practices and applications especially for residential.

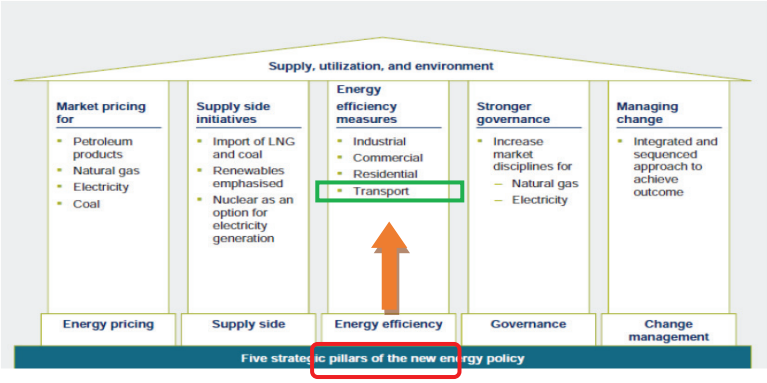

Fig. 3. Pillars of the New Energy Policy

EE improvement from the demand-side is a crucial part of the energy sector development as the demand dictates the energy supply and fuel consumption. Savings on the demand side reduces energy losses due to distribution and transmission of power, losses in power generation plants, and the energy use associated with extraction and transportation of fuels. In energy terms, saving one unit of energy in the demand side will save 3-4 units of primary fuels. In view of this, the Malaysia EE Action Plan is focused on tackling issues pertaining to energy supply by managing demand efficiently. Based on the National Energy Efficiency Action Plan (NEEAP) for the year 2014 by KeTTHA, figure 4 show five main thrusts will drive the nation towards more sustainable energy [7].

Thrust 1	Establish an overall long-term national plan for EE
Thrust 2	Strengthen Implementation Capacity to Promote EE
Thrust 3	Create adequate and sustainable funding mechanism for EE
Thrust 4	Implement EE programmes
Thrust 5	Enable commercial finance institutions to support EE

Fig. 4. National EE Action Plan adapted from Annual Report for 2014

The Malaysia Energy Efficiency Action Plan contains 17 specific EE programmes that cover three sectors to be implemented over a 10 year period and the programmes as shown in Figure 5 below:

Initiative 1	Rating and labelling of appliances
Initiative 2	Minimum Energy Performance Standards (MEPS)
Initiative 3	Energy Audits and Management in Buildings and Industries
Initiative 4	Targeted "Kick Start Promotion Bonus" and support programmes
Initiative 5	Energy Efficient Building Design

Fig. 5. Key Initiatives for Energy Efficiency Programs

From the issues stated, there have a several question should be asked:

i. Is the end-user (residential) knowing about EE practice and application?
ii. Does the end-user knowing the green technology approach established by KeTTHA and regulated by the Energy Commission and electricity supplied by TNB and IPP.
iii. Does there have any system that can be implemented to show the evaluations of EE and the energy saving percentage towards reducing electricity bills?
iv. There have any specific guideline on home appliances EE?

3. Objectives of Study

EE is claimed as world and national issues. The Malaysian people should have the awareness about green energy for sustainable development. To show the commitment and need to participate in this issue, the objective has been set-up. The objective of this study is as follows:

i. To survey the energy efficiency practice and application in residential building
ii. To develop a database on energy related–appliances for residential building by using green technology approach (according to KeTTHA, Energy Commission and TNB)
iii. To develop an Energy Efficiency Evaluation System (EEES) for the user / consumer that can be implemented to the Malaysian.
iv. To propose the Energy Efficiency guideline for residential

4. Methodology

The research design of this study is formulated by several key components of the whole study. The study looks into Malaysian Economic Development and its historical energy demand and consumption. Bearing in mind the constraint in supply of finite energy as well as its environmental impact (case

reported by Energy Commission, KeTTHA and TNB) energy efficiency EE was chosen as the theme of this study. Figure 6 highlights the research framework and the expected outcome of the research.

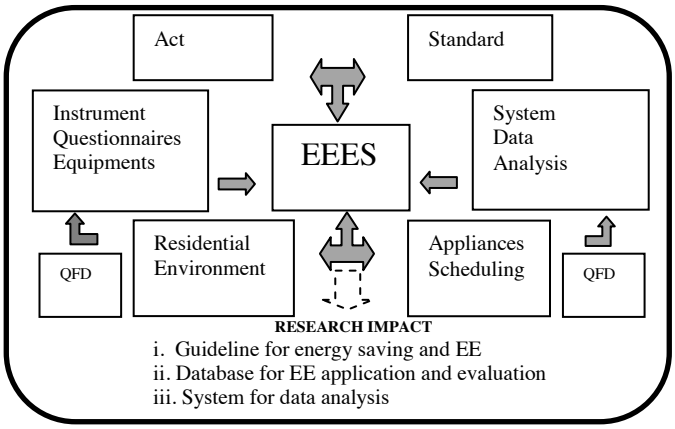

Fig. 6. Proposed Research Framework

Data collection as follows;

i. Questionnaires
   a) Energy efficiency practice and application in residential (use QFD approach) [9,10]
   b) Energy consumption by consumers (Energy bills and form) [8, 11]
   c) System development (use System Development Life Cycle, SDLC approach) [11]
ii. Data on energy related–appliances for residential building that uses green technology approach.

Figure 6 shows the research framework with its components summarized. Legislative acts form an important element in this research with Petroleum Act 1974 as a major reference, supported by Electrical Supply Act 1990 (ESA 1990), Energy Commission Act 2001 (ECA, 2001) and Renewable Energy Act (REA, 2011). They provide guidelines to electricity supply and tariff for the country as well as permissible actions among industry players.

The second element in the research framework involves standards and codes of practice. In this study, certain standards are more in focus, Malaysian standard MS 1525: 2001 Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings in particular. Industry Code of Practice on Indoor Air Quality [12] is also referred. The third element is residential environment as the scenario being studied. In that process, 3 case studies were set-up to gather data regarding residential areas. The fourth element is appliances, of which the scheduling of usage and EE training are considered. In this element, the human capital and the awareness on EE must be enhanced and a culture of energy conservation must be developed. The other element including system, data and analysis need to be clarified and study due to the needs of the development of EEES according to green technology approach by KeTTHA and Malaysian Green Technology Corporation, Malaysia. The QFD is a tool used to ensure customers' preference and opinion are taken into account. The questionnaires that were developed are based on the QFD techniques and the analysis will give a clear picture and represent customers' needs.

4.1 Quality Function Deployment (QFD)

Quality Function Deployment (QFD) is a method for developing a design quality aimed at satisfying the consumer and then translating the consumers' demands into design targets and major quality assurance points to be used throughout the production phase [13]. Frequently, QFD is employed to manage design information and assist decision making in human centered product development [14]. Studies have

recognized that the identification and implementation of customer requirement are two significant issues to ensure successful product development [15]. QFD can be defined as a customer-oriented approach to product innovation. It guides product managers and design teams through the conceptualization, creation and realization process of new products [9,10].

4.2 Development of System Based on System Development Life Cycle (SDLC)

There are currently many different methodologies employed for system development projects. System Development Life Cycle (SDLC) is the process consisting of a series of planned activities to develop the software products. The system development should progress through the six phases including system initiation, system requirements analysis, system design, system construction, system acceptance and system implementation. The SDLC process are shown in the Figure 7 below.

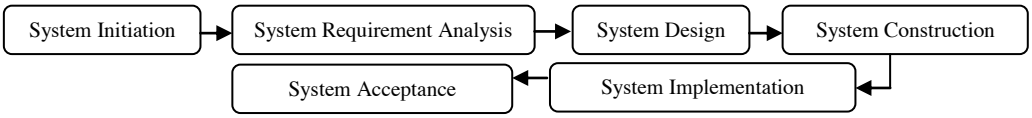

Fig. 7. System Development Life Cycle (SDLC)

5. Expected Result

It is expected that a reduction in electricity bills will be obtained when promoting EE behaviour. The EE related data would enhance understanding of energy consumption. Consumers will estimate their energy consumption more systematically. In a wider national context, it has the potential to bring the country to its developed country status. It is apparent that EE is a key element in energy consumption and conservation and a source for effective domestic trade. Furthermore, the result would be beneficial to government's green technology projects and hence aid the country's sustainable development.

6. Acknowledgement

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