



REDUCING ENERGY CONSUMPTION BY USING ENERGY EFFICIENCY APPROACH FOR HOUSEHOLD ELECTRICAL APPLIANCES: A COMPARISON BETWEEN MALAYSIA AND SOUTH KOREA

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ABSTRACT

Improvement in standards of living in Malaysia makes people using more modern electrical appliances at home. Electrical appliances for residential building consume a significant amount of electricity in the domestic sector. Efficiency improvement of these appliances will give a significant impact on future energy consumption for this country. Standards and Labeling (S&L) has been implemented around the world and energy efficiency (EE) can be considered as an important strategy to reduce the energy consumption. Malaysia has adopted the minimum energy performance standard (MEPS) approach to implement S&L programs. South Korea is one of the developed countries that also implement MEPS. This paper discussed the implementation of MEPS as EE standards and labels in Malaysia and South Korea. The comparison on testing procedure and energy efficiency label between these two countries also has been discussed. Therefore, some recommendations to improve S&L in Malaysia also provided regarding the success of its implementation in South Korea. The methods to calculate and identify EE standards and labels that provide some useful information for identifying energy efficient products have been reviewed between these countries. The implementing of EE standards and labels will save a huge of energy, as well as beneficial to the environment. Therefore, it will encourage consumers to use the energy efficient electrical appliances.

Keywords: energy efficiency (EE), energy consumption, standards and labeling (S&L), minimum energy performance standards (MEPS), energy label.

1. INTRODUCTION

In this modern era, electrical appliances have become indispensable necessities of home life. In developing countries, electrical appliances production and application have grown up rapidly. It is reported that energy consumption for electrical appliances consumes a huge amount of energy to operate. According (Ponniran, Mamat, & Joret, 2012), household electrical appliances such as refrigerator consumed high electricity in domestic sector. EE is among the best solution could be implemented regarding this issue. Any efficiency improvement for these appliances will produce a significant amount of electricity consumption in the domestic sector. The Malaysian authority (i.e. KeTTHA, Energy Commission and Tenaga Nasional Berhad) also considering to implement minimum EE standards as a target to reduce the energy consumption especially for residential sector. USA, China, Japan and South Korea also implement minimum EE standards for electrical appliances (T. M. . . Mahlia, Masjuki, Saidur, & Amalina, 2004). Standards and Labeling (S&L) program is one of the program that has been introduced to help consumers purchasing an efficient electrical appliances. In order to implement an effective S&L program, this paper aims to compare S&L programs in Malaysia with similar programs that have been successfully implemented in South Korea. It is important to acknowledge the potential of this program to be made mandatory, and to improve

existing programs in Malaysia. Other than that, it is important to understand the theories of the law and practical knowledge on the implementation of the S&L program.

1.1. Energy consumption and energy demand

South Korea and Malaysia are among the rapidly growing economies in the Asian region. Both experienced rapid industrialization and increase in economic activities, leading to accelerated use of energy during the last four decades from the 1960s to the 2000s (Sa'ad, 2011). Malaysia's electricity demand mostly by natural gas and to a lesser extent coal. This high demand driving the country to diversify the power generation fuel mix and add electricity capacity to avoid future power shortages. The rapid economic development and population growth have resulted in the significant higher electricity generation over the past decade. According to international energy data and analysis by EIA (U.S Energy Information Administration (EIA), 2014a), Malaysia's electricity generation doubled in the past decade, total of 134 billion kWh in 2012. The electricity demand expected to grow by more than 3% at least through 2020. Peninsular Malaysia stated as the high demand for electricity is facing fuel shortages in natural gas. Malaysia is seeking to diversify the power generation fuels and reduce the cost of fuel sources. According to the Energy Commission of Malaysia, the industrial sector is the primary source of



power demand and accounted for about 45% of the total in 2012. Commercial and residential demand were 33% and 21%, respectively. Transportation and agriculture made up less than 1%. Figure-1 below shows the breakdown of the electricity consumption in Malaysia for the year 2012. In Malaysia, more than 50% of domestic consumers use less than 200 kWh of electricity monthly (Association & of Water and Energy Research Malaysia (AWER), 2012). Therefore, electric and electronic appliances are increasingly the target of energy efficiency standards.

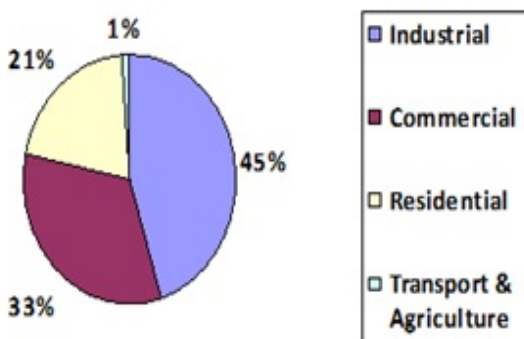


Figure-1. Electricity consumption breakdown by sectors in Malaysia.

On the other hands, South Korea have high rates of increase in final energy consumption, using over twice as much in 2003 as in 1990 (Nakagami, Murakoshi, & Iwafune, 2008). In 2012, South Korea generated about 495 billion kWh of net electricity. South Korea's power generation has increased by an average of 5% annually over the past decade and expects demand to grow 3.7% annually until 2017 and industrial sector as the largest consumer. Fossil fuels accounted for 70% of total generation, while 29% came from nuclear power, and nearly 2% came from renewable sources. Coal generation makes up the majority of fossil fuel generation. Although fossil fuel-fired capacity is dominant in South Korea at present, nuclear power is set to expand over the next decade, along with significant investment in renewable sources such as solar and tidal power. In 2012, about 53% of electricity consumption came from industries, 25% from commercial and service enterprises, 14% from the residential sector, and 8% from other sectors like transportation and agriculture (U.S Energy Information Administration (EIA), 2014b). Figure-2 shows the breakdown of the electricity consumption in South Korea for the year 2012.

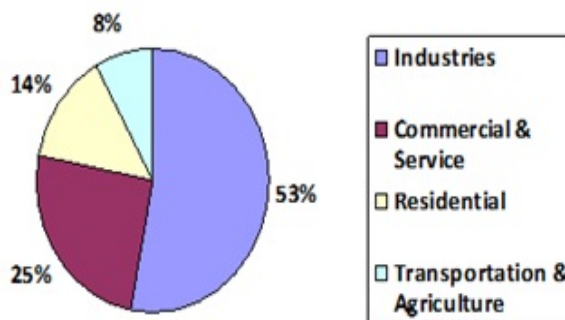


Figure-2. Electricity consumption breakdown by sectors in South Korea

According to the International Energy Agency (IEA) forecasts, global energy demand will increase by 40% between the years of 2007 and 2030 (IEA, 2009). Global primary energy demand is expected to increase to 35% by the year 2035 even assuming energy efficiency policies are implemented with full success. This increased would cause a huge impact on energy costs and energy security, especially for access to energy for economic growth, societies' poorest people and climate change (Tricoire, 2013). EE is one of the methods used to overcome this issue. EE for household appliances are among the most popular strategies to save energy, and educate consumers to use energy wisely. Although, the energy demand has the different between South Korea and Malaysia due to the different climate, the similarity on the implementation to household electrical appliances still can be made.

1.2. Standards & labeling (S & L)

The critical supply of energy is becoming a world issue in recent years. Minimum EE is one of the most popular strategies to reduce the energy consumption and at the same time it can educate the consumers. In Malaysia, the Association of Water and Energy Research Malaysia (AWER) were proposed to use the S&L programs for electrical and electronic products. S&L programs had been used by many countries throughout the world. This program could be the most cost-effective EE program, which needs the minimum cost to deliver the largest quantity of energy savings. S&L regulations bring more benefit for the most major classes especially for consumers (Shi, 2014). This standard shows the minimum EE levels of electrical appliances that can be sold in the market. Regarding this issue, Malaysia has adopted the minimum energy performance standard (MEPS), which was introduced by the International Energy Agency (IEA) and have been gazetted on 3rd May 2013 by the Minister of Energy, Green Technology and Water Malaysia (KeTTHA). Currently, MEPS mandatory has been applied for five types of household electrical appliances (Energy Commission, 2014b). Figure-3 shows the EE label for electrical appliances in Malaysia.



Source: Energy Commission of Malaysia, 2014

Figure-3. Energy star rating in Malaysia.

In the same way, EE Standards & Labeling Program (included MEPS) has been launched in South Korea in 1992. Currently, the program covers 22 target products, including refrigerators and air conditioners. Appliances with the energy efficiency label are covered with MEPS and an energy efficiency ratio (EER). Figure-4 shows the EE label for refrigerators and fluorescent lamp ballasts that been used in South Korea (Hathaway & Zhao, 2011).



Figure-4. EE label for refrigerator and fluorescent lamps ballast.

The High-Efficiency Appliance Certification Program has been implemented in South Korea since 1996. 41 target products, including induction motors, boilers, and lighting equipment are involved in this program. It is a voluntary certification scheme that aims to promote the High-efficiency Appliance and initiative market. Furthermore, Korea has been running another similar energy efficiency program called the E-Standby Program since 1999, but this program aims to reduce standby power of electronic appliances and office equipment. The E-Standby Power Program included 20 products at that time. Additionally, seven products have been changed from a voluntary reporting scheme to a mandatory reporting scheme since August 28th, 2008. Figure-5 shows the number of product MEPS implemented Malaysia, South Korea and other countries (Dungen & Carrington, 2011). These countries also have a number of pending standards awaiting regulatory approval. According to Dungen (Dungen & Carrington, 2011) based on the report on 2011, MEPS also has been implemented in other countries such as USA, China and

Japan which USA has the highest number of approved standards (46) followed by China (41), Japan (27) and Korea (25). At that time, Malaysia only applied for (1) electrical appliances and (4) others under consideration but currently Malaysia has been applied for five electrical appliances including refrigerator, air conditioner, television, fan and lamp.

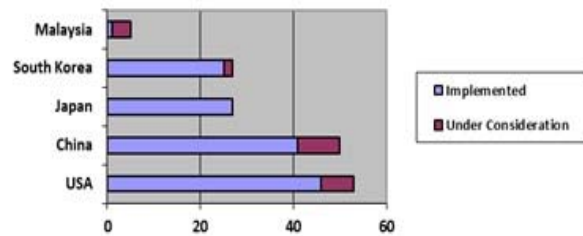


Figure-5. Overview of the number of mandatory maps for Malaysia, South Korea and other countries

Based on a review of these countries, it was found that the S&L program is one of the EE concepts that have been used worldwide. EE labels encourage people to buy products that are more efficient by letting them understand and compare how much energy used. The purpose to introduce labels is to convince consumers to buy EE appliances (T M I Mahlia, Masjuki, & Choudhury, 2002). At the same time also influence the manufacturers to produce more EE products into the market.

2. ENERGY PERFORMANCE AND TESTING PROCEDURE

Products covered by minimum energy performance standards (MEPS) must meet or exceed set levels of energy performance before they can be sold to consumers. Setting energy performance levels create a more efficient range of products for consumers to choose from by:

- Encouraging manufacturers to continually improve the efficiency of their products
- Preventing poorly performing products from being sold
- Improving the average efficiency of products available here.
- In general, three approaches can be distinguished for setting the MEPS level based on the variation in efficiency in products on the market:
 - A minimum efficiency approach where the level is set to cut off around 20% of the market.
 - An average efficiency approach where the level is set to cut off around 50% of the market.
 - A maximum efficiency or top runner approach where the level is set to cut off around 80% of the market.

The development of a test procedure for rating and testing is the first step in the development of EE standards. An energy test procedure is the technical foundation of energy efficiency standards, energy labels



and other related programs (T.M.I. Mahlia & Saidur, 2010). Testing procedure is a laboratory test or protocol to provide manufacturers, regulatory authority and consumers a way of consistently evaluating the energy performance of appliances across different brands and models through energy labels (T.M.I. Mahlia & Saidur, 2010). The two international authorities that responsible for appliance energy test procedures are the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). In Malaysia, to meet the requirements of S&L, the performance criteria testing standards have to be met are as follows (Energy Commission, 2014a). Eq. 1 shows the equation used to calculate the Star Index.

$$\begin{aligned} EEF_{average (1 door)} &= 1.37 V_{adj} - 63.3, \\ EEF_{average (2 door)} &= 0.409 V_{adj} + 119.5 \end{aligned} \quad (1)$$

Where,

$$Star Index = \left(\frac{EEF_{tested}}{EEF_{average}} - 1 \right) \times 100\%$$

$$Energy Efficiency Factor (EEF) = \frac{Adjusted Volume (litre)}{Energy Consumed per day (kWh)}$$

3. DISCUSSION

Compared to the other countries, energy consumption can be reduced by using EE approach. MEPS is the current EE approach that widely using for many countries, especially in the Asian region including Malaysia and South Korea. However, the factor for reducing energy consumption depends on several factors. There is less energy consumption by households in South Korea because Korean households have relatively small floor areas. The climate is one of the factors to be considered. For example, the heater mostly had been used in the winter season and the air conditioner was highly used in summer season. When one considers space heating energy consumption per unit area, Korean consumption is at a level comparable to Malaysian households. Despite that, among Asian countries, there are many electric cooking appliances, such as the electric hot water pot, and these consume much electricity. Major electricity use in South Korea is home appliances and the ownership of major appliances such as refrigerator, TV, VTR, and PC. In both countries, it is likely that the saturation of household electrical appliances will increase. As the number of electrical appliances in use grows, it is possible that electricity consumption will grow to exceed the levels of households. On the other hand, the energy label used is different depending to the country. It is much easier and practical if the energy label that has been used has the same standard size for all countries. Furthermore, based on the review of EE approach from other Asian countries, these steps do not necessarily take place in stages, but can occur simultaneously such as electrification (expansion of electricity supply) mainly in electricity demand and

improving living standards. In this study, in the both countries Malaysia and South Korea it is likely that household energy consumption will continue to rise. It is necessary to understand conditions in each country precisely, in order to implement more effective energy policies. Finally, it is important to produce a data base of energy efficiency indicators for each country for sharing information and goals.

4. CONCLUSIONS

Based on the review, it has been observed that EE standards and labels are an effective strategy to reduce energy consumption for household electrical appliances and its offer many benefits. South Korea has successfully adopted the S&L programs and has implemented to 27 electrical appliances (Dungen & Carrington, 2011). As a developing country, Malaysia also had implemented the S&L program and currently applied for five electrical appliances. Implement this standard to other appliances is a recommendation to improve this program. The implementation of EE standards and labels will encourage manufacturers to produce energy efficient products and this will increase the competitiveness for the local and international market. However, an appropriate experiment and energy test procedure must be done to support any EE strategy and must be established before EE standards and labels are developed. Furthermore, it is important to give the right information to help the consumer to choose the lowest energy consumption of electrical appliances.

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