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ELECTRICITY SAVINGS BY IMPLEMENTING ENERGY EFFICIENCY STANDARDS AND LABELS FOR CLOTHES WASHERS IN MALAYSIA

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Abstract

Clothes washers being one of the energy consuming household appliances in Malaysia have become a target for energy efficiency improvements. In the present study, a series of experiment investigations have been conducted on six clothes washers of varying capacities. The objectives are to develop the standards and labels. The test has been performed according to IEC (International Electrotechnical Commision) clothes washers test specification. Using the experimental data, a baseline standard has been developed by statistical method. From the baseline standards, 10% standards have been developed. The baseline unit energy consumption was calculated to be 32 Wh/kg/cycle (average unit energy consumption of the six models) and on the basis of baseline unit, standard unit energy consumption had been proposed to be 29 Wh/kg/cycle. It has been estimated with the introduction of minimum energy efficiency standards for clothes washer 38077037.46 kWh of energy could be saved per year. To develop a comprehensive energy guide labels, three labels had been design, which were star labeling, speedometer labeling and letter bin labeling. A survey was conducted with three different types of labels among the consumers and with the surveys respond, energy guide label of household clothes washers has been proposed for Malaysia. This is result from used of energy-efficient appliances product and is well positioned to promote more widespread efficient improvement.

Keywords: Household appliances, Clothe washer, Energy efficiency standards, Energy labelling, Energy saving.

1. Introduction

Energy efficiency standards are a set of procedures and regulations that prescribes the energy performance of manufactured products, sometimes prohibiting the sales of products that are less energy efficient than the minimum standards [1]. It means that the appliance manufacturer must meet the minimum efficiency level set by the standards in order to sell the products. Energy efficiency standards can be either mandatory or voluntary; they can be in the form of minimum allowable energy efficiency or a maximum allowable energy use. Energy standards consist of three types, which are: prescriptive standards, minimum energy-performance standards (MEPS), and class-average standards [2].

Energy labels are informative labels that are attached to manufactured products and describe a product's energy performance in the form of energy use, efficiency, or energy cost. Energy labels create consumers awareness by convincing them to buy more efficient appliances. Energy labels also encourage manufactures to improve the standards of their products and use efficiency as feature of their sales campaign. There are three types of energy labels, namely: endorsement, comparative, and information-only [3].

Energy efficiency standards and labels had been introduced since the early 1960s in Europe, as a step in bounding the energy consumption of domestic appliances. At that time, much of these regulations were weak and poorly implemented. During the late 1970s and 1980s, almost all of these nationally based legislation were being repealed during the late 1970s and early 1980s, due to pressure to harmonize European trading conditions [4]. Today, energy efficiency standards and labels are among the most popular, simple, and effective strategy for providing guidance to residential consumers in their purchase of household appliance.

1.1. History of household appliance standards and labels

Household appliance standards were become popular just after oil price shock in 1970s. Both United States and European Countries proclaimed that they are the first countries who implemented energy efficiency standards and labels for household appliances. However, the literature surveys had shown that the European government was among the first introducing legislation to limit the energy consumption of domestic appliances during the 1960s and 1970s [4]. In the early of 1962, Poland introduced the first mandatory energy efficiency standards for a range of industrial appliances. The French government alleged mandatory energy efficiency standards for refrigerator in 1966 and 1978 for freezers. Other European Governments such as Russia, declared mandatory energy standards in 1976. However, much of this early legislation was poorly implemented and had little impact on appliance energy consumption, and was canceled in the late 1970s and early 1980. The first energy-efficiency standards that dramatically affected manufacturers and significantly reduced the consumption of energy were mandated in the United States by the state of California in 1976. These standards became effective in 1977 and were followed by national standards that became effective in 1988 [2]. In 2000, as many as 15 governments around the world have adopted mandatory energy efficiency standards.

Among the south East Asian nations, Philippines and Thailand are leading the way towards the development of national standards for energy conservation [1]. These two countries have well established programs in improving the efficiency of household appliances. Other countries such as Australia, Brazil, Canada, China, Japan, India, Korea, Mexico and Taiwan, have applied either energy standards or energy labeling or both. Energy Standards and Labeling Programs can be either mandatory or voluntary. The history of appliance standards is shown in Table 1.

Table 1. Overview of the Appliances Standard History.

Year Effective	Country	Legal Status	Appliances
1962	Poland	Mandatory	Several
1966	France	Mandatory	R
1976	Russia	Mandatory	Several
1979	Japan	Voluntary	RAC/LT/R/FR/TV
1978	Canada	Mandatory	16 products
1989	China	Mandatory	R
1980	US	Mandatory	R/AC/RAC/CW
1991	Taiwan	Mandatory	RAC
1987	Australia	Mandatory	R/RAC/AC/DW/CD/CW
1992	Korea	Voluntary	R/FR/RAC/LT
1993	Philippines	Mandatory	RAC
1994	Thailand	Voluntary	R/RAC
1995	Hong Kong	Voluntary	R/RAC/CW

Note: Refrigerator (R), Freezer (FR), Room Air Conditioner (RAC), Central Air Conditioner (AC), Cloth Washer (CW), Cloth Dryer (CD), Dish Washer (DW), Lighting (LT), Television (TV).

1.2. Worldwide energy efficiency program for clothes washers

Many countries have introduced energy efficiency standards for clothes washers with very successfully outcome which other countries can learn the experience. Some experience can be directly adopted but some must be modified to make it suitable for particular countries. As an example, the U.S. department of energy (DOE) promulgated the standards for clothes washer. The European Union has been working on long term efficiency targets for clothes washers [1]. China presently has established minimum energy performance standards for clothes washer. The Philippines and Thailand, through the energy efficiency programs developed, has transform their markets for energy efficient product [5]. Although energy efficiency programs for clothes washer start in 1980, the Malaysian people are still unaware of its importance and there are no sufficient government regulation and incentives to stimulate the adoption of energy efficiency in domestic sector. Therefore, manufacturers are not aware of making their products more and more efficient compare to other countries. Until now, there is no minimum energy efficiency standard and label for household clothes washer in Malaysia. As a result, consumer doesn't know how efficient the product that exist in market. Inefficient clothe washer are contributing to the lost of country's energy resource. Consequently, it is evident that efficient utilization of energy efficiency standards and labels and government intervention in this sector will help to reduce future demand for setting new power plant as to mitigate the

carbon, sulfur, nitrous and particulate emission and ozone depletion of the environment. Therefore, it is expected that energy efficiency for clothes washers could be set and expanded in Malaysia in growing its economy from the sustainable energy standpoint.

1.3. Electricity consumption for Malaysia's domestic sector

Electricity demand in domestic sector is always driven by the growing number of households and the development in household income distribution. In 1998, a study has been done and estimated that an average family in low cost house spends about RM65 (about US$17) per month. The electricity expense is around RM110 (about US$30) per month for a medium cost house, while the electricity can go up to RM350 (about US92) per month for a bungalow [6]. Home consumption of energy would depend very much on family size, living habitats, appliances installed, the hours of use and the efficiency of the equipment. The consumers of electricity in a typical Malaysia terraced house of about 180 m^2 are shown in Fig. 1 [7].

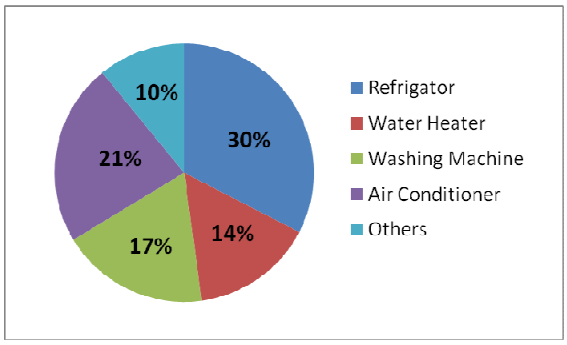

Fig. 1. Average Energy Used by Various Appliances for 180 m^2 Terrace House.

2. Methodology

An energy test procedure is the technical foundation for all energy efficiency standards, labels and other related programs. Energy label can not be created without an energy test procedure. Standards are, from an enforcement standpoint, impossible without labels. Government or utility incentive programs can be implemented in conjunction with standards or independently, but labels are still necessary. Their relationships in developing standards and labeling are presented in Fig. 2.

In the present study, series of experiment investigations have been conducted on six clothes washers on varying capacities. The test has been performed according to IEC clothes washer test specifications [4]. The experiment equipments that have been used for accomplishment of this study are below:

- Power Meter
- Weighting machine
- Computer (with "Corel Draw 9" software)
- 6 units of Clothe Washer (with different Models).

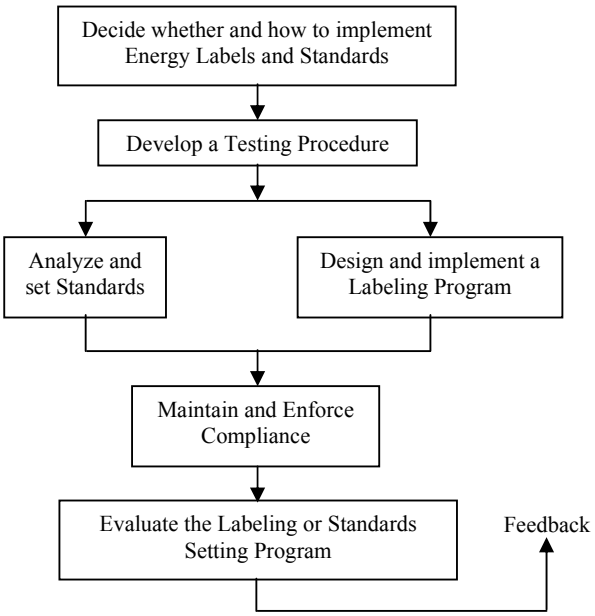

Fig. 2. Typical Steps in the Process of Developing Consumer Product Energy-Efficiency Standards and Label.

2.1. Experimental procedures

An energy test procedure is an agreed-upon method of measuring the energy performance of appliances. The results of an energy test procedure may be expressed as efficiency, efficacy (for lighting product) annual energy use or energy consumption for a specified cycle, depending on the appliance being tested [4]. The primary purpose of an energy test procedure is to rank similar product by their energy performance. In the present study, energy consumption for each of clothes washer had been measured using power meter. The experiment was set up from 1kg until 6 kg load depending on the clothes washer's capacity. After measuring energy consumption, all the data had been collected and analyzed.

2.2. Label design

Labels for clothes washer were designed using "Corel Draw 9" software. Three types of different labels were designed and survey was conducted among the student and staffs in University Malaysia Sarawak (UNIMAS) to select the best design of label for clothes washer.

3. Results and Discussion

Six different models of clothes washers were used for the experiment. All of the six clothes washers are automatic of varying capacities. The experiment had been set up from 1kg load and the load had been increased for every 1kg until

maximum 6 kg depending on the clothes washer capacity. Every experiment used top loading clothes washer and normal/standards cycle. From this experiment, energy consumption of each clothe washer had been recorded using power meter. The energy consumption of different models of clothes washers' test units are shown in Table 2. The clothes washers are normally operated with a nominal maximum load. But in this study, the experiment had been set up of varying load to observe the variation of energy consumption. It has been shown in Table 2 that energy consumption of all models increased with the increase of load although the increase of energy consumption is not so significant.

Table 2. Energy Consumption of Different Test Units.

Load	Energy Consumptions of Different Models (Wh/cycle)					
(kg)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
1	68.91	73.10	90.28	100.01	69.01	88.10
2	80.80	78.76	95.19	102.21	85.62	100.97
3	91.20	93.40	101.72	107.01	120.82	149.82
4	94.06	96.81	104.23	110.71	126.98	152.31
5	100.20	139.21	107.40	116.91	129.18	155.91
6	-	151.29	110.38	-	132.30	160.01

3.1. Development of energy efficiency standards

In the present study, statistical approach was used in developing the energy efficient standards. Six household automatic clothes washers (models available in Malaysia in 2007) were tested in developing standards that was shown in Fig. 3. For each model, energy use per standard cycle (i.e. energy consumption as per IEC test conditions) is plotted as a function of load. From the graph, using regression analysis of all data point, two lines were shown, upper line represented the average energy use (reference line) and the lower line represented 10% energy saving line.

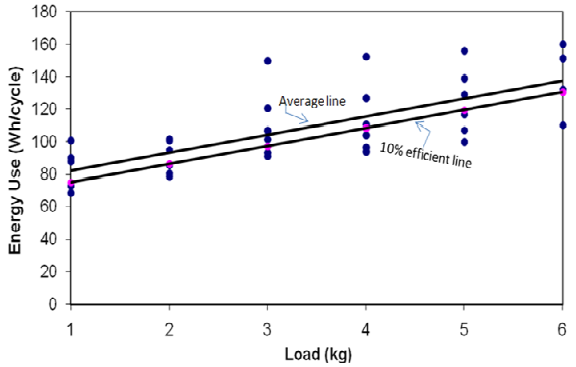

Fig. 3. Energy Use per Cycle of Clothes Washers is Shown as a Function of Load.

Table 3 shows proposed energy efficiency standard for clothes washers in Malaysia on the basis of the study. Average unit energy consumption for standard cycle were found to be 29 Wh/kg/cycle for Model 1, 30 Wh/kg/cycle for Model 2, 29 Wh/kg/cycle for Model 3, 36 Wh/kg/cycle for Model 4, 32 Wh/kg/cycle for Model 5, and 38 Wh/kg/cycle for Model 6. The baseline unit energy consumption was calculated to be 32 Wh/kg/cycle (average unit energy consumption of the six

models) and on the basis of baseline unit, standard unit energy consumption had been proposed to be 29 Wh/kg/cycle.

Table 3. Proposed Energy Efficiency Standards for Clothes Washers.

Model	Average Load (load)	Average energy consumption (Wh/cycle) (x)	Unit energy consumption (Wh/cycle) (y)	Baseline energy consumption (Wh/cycle) ($\sum x/6$)	Baseline unit energy (Wh/cycle) ($\sum y/6$)	Standard unit energy (10% efficient over baseline) (Wh/kg/cycle)
1	3	87	29	108	32	29
2	3.5	105	30			
3	3.5	102	29			
4	3	107	36			
5	3.5	111	32			
6	3.5	135	38			

The proposed energy is 10% more efficient than the baseline unit. Therefore, it has been found that Model 1 and Model 3 that were 10 % more efficient than baseline unit were the most efficient model, Model 2 and Model 5 that fell within 10% of the baseline were the average efficient and Model 4 and Model 6 that were less efficient than baseline were the least efficient. Less efficient models consume high energy, Model 4 and Model 6 that were least efficient should be removing in the market and replaced with other model that is more efficient.

3.2. Development of energy efficiency labels

The energy efficiency labels are part of the energy efficiency standards and clearly identify the maximum and minimum efficiency levels for each appliance. Implementing labeling in clothes washers program can create consumer awareness about cost of operation, create a demand for more efficient model of clothes washer, provide a new avenue for competition for the manufacturer, reduction in energy use and lower operating cost and prevent "dumping "of inefficient product. In this study, three comparative labels (star labeling, letter bin labeling and speedometer labeling) have been designed (shown in Figs. 4-6). Energy efficiency labels inform the following information:

- Appliance type (clothes washer)
- Brand, model and manufacturer
- Energy efficiency level for the denoted appliances
- Range of energy efficiency for equivalent models
- Annual energy consumption
- Appliances characteristic
- Relevant test standards.

Star labeling can be illustrated by the rating of hotels in the world. In hotel rating, more stars represented more quality of the hotel. In this energy efficiency label, more star mean more efficient the appliances. The efficiency scale of this label is from one star until five stars, one star indicates the least efficient and 5 stars indicate most

efficient. Letter bin labeling comes with alphabet from A until F inside the different length of bar. The length of bar is increased incrementally from A until F. Alphabet A with shorter length of bar indicate higher energy efficient/lower consumption of appliances and alphabet F with longer length of bar indicate least energy efficient/higher consumption of energy. This labeling comes with the concept of adjusting volume of hand phone. Speedometer labeling is based on the concept of car speed. With this concept, consumer will realize that higher the speed, higher the energy consumption and lower the speed, lower the energy consumption. This label also comes with number. The scale is from 1 to 5. Number one indicates most energy efficient and number 5 indicate least energy efficient. From Figs. 4 to 6, it can be observed that biasness has significant influences on the understanding of the labels. If labels are not read by the consumers before asking for their responses, the objective of the labeling would not be fruitful.

In this study, three types of labels (star, letter bin, and speedometer) were placed before the student of University Malaysia Sarawak, University staffs, and also the general people to select a label that would be more acceptable for household clothes washers. A brief discussion was then made explaining the meaning of labeling (i.e. star, letter bin, and speedometer), expected consumer benefit of labeling in terms of energy, bill savings and emission reduction associated with the energy savings. Yearly operating or life cycle cost (LCC) has also been illustrated so that the consumers can identify relative advantages of buying an energy efficient clothes washer. Finally, the consumers were asked to fill out the survey form. The survey output has been shown in Table 4.

From Table 4, it is clear that letter bin labeling is selected majority of the consumers. It is expected that policy makers of Malaysia may introduce letter bin labeling in consultation professionals, experts, and manufacturer of clothes washers. For the maximum benefit, policy makers are recommended to introduce a comprehensive mass media program on labeling to create consumer awareness. Even though energy labels are spreading from many countries around the world, the references for developing energy labels are very limited. The study has presented the energy label proposed for clothes washers in Malaysia that could be used elsewhere too in order to save energy. The label letter bin of clothes washers is only effective for a limited period of years, because energy efficiency of the clothes washers will continuously improve due to technological advance. Therefore, after a certain period, most of the appliances will receive the highest energy efficient label A and the label will lose its effectiveness. At that time the letter bin label need to be revised in accordance with the average rating of clothes washers in the market.

Table 4. Labeling Survey Output.

Labeling Types	Number of Respondents	%
Star Labeling	29	18.35
Letter Bin Labeling	71	44.94
Speedometer Labeling	58	36.71
Total	158	100

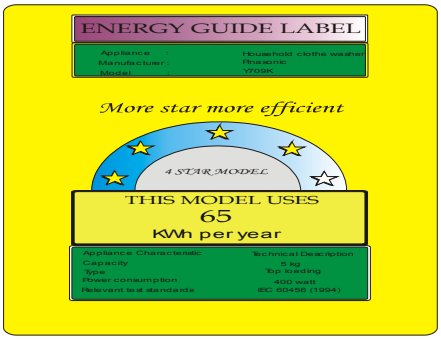

Fig. 4. Star Labeling.

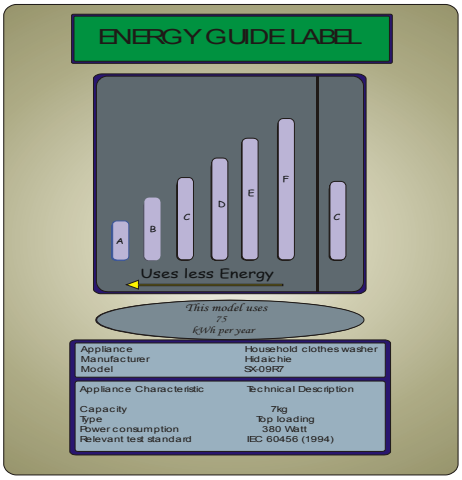

Fig. 5. Letter Bin Labelling.

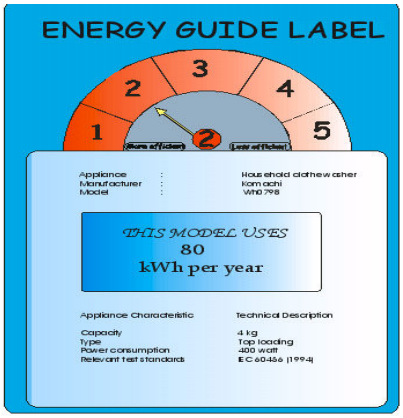

Fig. 6. Speedometer Labeling.

4. Conclusions

In the present study, six automatic top loading clothes washers with different capacity had been tested. The measurement methods have been followed IEC clothes washer's test specifications. The test is set up using varying load, which is from 1 kg until 6 kg depending on each unit of clothe washer's capacity. The baseline unit energy consumption was calculated to be 32 Wh/kg/cycle (average unit energy consumption of the six models) and the standard unit energy consumption has been proposed to be 29 Wh/kg/cycle (10% more efficient than baseline unit). Three labels had been design, which were star labeling, speedometer labeling and letter bin labeling. A survey has been conducted for the selection of the best designed and the most accepted one. From the survey response, a comprehensive energy guide label "Letter bin label" has been proposed for clothes washers in Malaysia. The study found that there are many advantages for Malaysia implementing an energy efficiency standard and label for clothes washers. The program will encourage manufacturers to produce energy efficient products, which will increase the competitiveness in the local and international market. The consumers will pay higher prices for appliances, which will be offset by lower electricity bills. Once the standard is implemented, inefficient products will be pushed out from the market. The standard and label must be periodically revised to continue progress in improving appliance efficiency. The standard indirectly also reduces environmental pollution. Moreover, it can be expected that this research has paved the way for establishing energy efficiency standard and label for household clothes washers as a starting point.

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