

Electricity Profile Study for Domestic and Commercial Sectors

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Abstract: As Malaysia move towards as a developed country, it is expected that the electricity consumption in domestic and commercial sectors will increase as well as more industrials and households need. This study is to investigate the electricity profile in domestic and commercial sectors by monitoring some appropriate appliances that contribute high electricity consumption. The characteristics for every major loads are examined and the potential energy saving is compared to an efficient electrical appliances in order to obtain the effective energy consumption. Questionnaires have been used to collect respondents, appliances and equipments information. For appliances and equipments measurement data, power quality equipment has been. Samples for domestic sector involved 150 respondents from three residential classes which are high, middle and rural. While for commercial sector, 100 respondents are involved which are restaurant, hotel, workshop, and store/office. It shows, in domestic sector, refrigerator appliance consumed high electricity meanwhile in commercial sector; compressor equipment contributed high consumption in electricity. It is also indicated that by using efficient electrical appliances it can reduce the amount of electricity consumption. However, instead of using high efficient appliances, human factor also contribute significant impact on reducing electricity consumption. By integrating between human factor, high efficient appliances/equipment and government policy, the electricity consumption can be used and managed wisely. Therefore the strategies to build energy efficient society have been proposed in order to achieve efficient electricity consumption.

Keywords: Electricity profile, Electricity consumption, Demand side management, Domestic sector, Commercial sector.

1. Introduction

Energy is one of the basic input factors of production, along with labor, capital, and material. After the oil embargoes of 1973 and 1979, both political and the scientific communities began to pay increased attention to the opportunities for improving the efficiency of energy use, [1].

Energy is the capacity or capability for doing work. All material possesses energy because they can all be utilized in some form of energy conversion process, [2]. For example, most substances will burn or vaporize, and the consequent heat energy can be harnessed within mechanical energy systems that create motion against some form of mechanical resistance. One of the important energies in human daily life is electricity.

People have started to think about consume electricity wisely and efficiently. Therefore, energy management is very important in order to produce goods and provide services with the least cost and least environmental effect. The term energy management means many things to many people. One definition of energy management is, "The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions, [3].

When people started concern about electricity energy management, the important key words need to highlighted are use electricity efficiently and wisely. This will accomplishes the two objectives of saving money and conserving main energy. Among the many features that might be addressed with regard to efficient utilization like monitoring and control of an environment will eliminate the input of excess energy and reduce the need for emergency intervention either in domestic or commercial sectors. In commercial and domestic sectors, the usage pattern of electrical appliances has been increased rapidly as long as the economic growth. It is because, a dramatic increase in the number of electrical appliances and equipments used which will be higher in the future and shows significant impact on the electricity consumption in Malaysia, [4,5,8,10]. Therefore, some strategies or plans need to be drafted in order for people to consume generated electricity from natural sources wisely and in efficient way.

Since independence, Malaysia has been experiencing rapid growth in economy sector and some of the effects are high electricity consumption because of high demands either in domestic or commercial sectors. The structural shift of Malaysia's economy from agriculture to industrial has brought an improvement of the living standards among Malaysians. This trends will continue to grow and

in one way or another will affect the total energy consumption. The domestic sector of energy consumption is determined by a number of factors such as the household income, the number of household and the average consumption level per household, [6,7]. While in the commercial building sector, some of the demand indicators for energy services are number of buildings, operating hours and a number of workers in a building [5,9,10]. The number of buildings, and operating hours of buildings, the higher the energy required for heating, cooling, lighting, and ventilation and other end uses.

In order to use electricity in electrical appliances in domestic and commercial sectors, the strategy of energy management is important to ensure no energy wasted in daily. So that, the purpose of this research is to identify electricity energy profile used by selected electrical appliances in both sectors and to suggest strategies in utilizing electrically wisely and efficiently.

2. Energy Demand in Malaysia

Fig. 1 shows the percentage of energy demand by main sectors in 2010 (source: Pusat Tenaga Malaysia (2010)). Residential and commercial sectors contributed about 12.8 % of total energy demand in 2012. These both sectors are the third largest energy demand among the other sectors and this number will be increasing in future based on current needs in Malaysia.

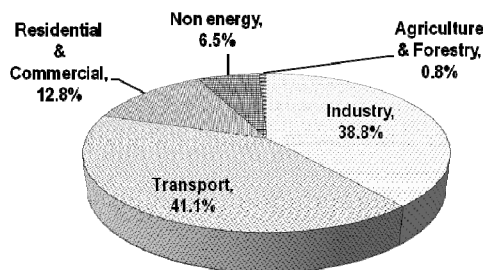


Fig. 1 Final energy demand by sectors in 2010
 Source of Data: Ninth Malaysia Plan 2006–2010, Table 19-2.

3. Methodology

3.1 Concept of The Study

Fig. 2 shows the block diagram concept of the study.

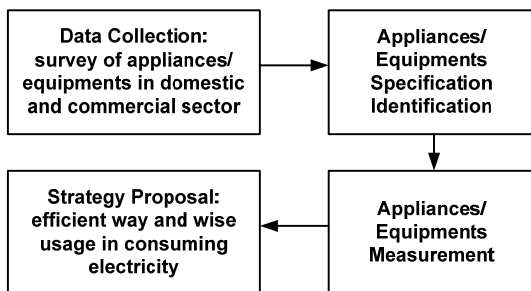


Fig. 2 Block diagram concept of the study

For the first step, data of electrical appliances and equipments either in domestic or commercial sectors are collected and identified by using set of appropriate questionnaires. Important information such as type of load, usage duration and monthly bill are included in the questionnaires.

Then, some of appropriate electrical appliances and equipments in domestic and commercial sectors are considered for measurement. For this purpose, parameter that considered is kilowatt hour (kWh) of the appliances and equipments. From that, the operation cost of the appliances and equipments can be estimated.

After perform some analysis, strategy of electricity utilization in efficient and wise ways is proposed. If possible, the outcome of the proposed strategy can be seen but it needs more time to test the strategy.

3.2 Data Collection and Measurement

150 respondents from three residential classes are chosen in order to obtain the ownership and usage time of electrical appliances among domestic consumers. The involved areas are Wangsa Maju and Taman Melati, both from Kuala Lumpur. 50 respondents are picked for each residential class, i.e. high, middle and low classes. Meanwhile for the commercial sector, 100 respondents are involved from four commercial types, i.e. hotel, restaurant, store/office and workshop. For the commercial sector, only Sri Rampai area from Kuala Lumpur is considered.

Questionnaires have been used as a survey instrument. Some of the details in questionnaire are background of the respondents, the ownership of electrical appliances, the duration (time period) of the operating appliances, electricity consumption (the mean monthly electricity fee and its consumption) and the significant factor that influence the household electricity consumption. From this the ownership and the usage pattern of electrical appliances can be obtained and estimated. The data from the survey become as an initial result to predict the major loads that can affect consumer's bill.

Then, major loads will be selected for measurement. For this measurement, power quality analyzer equipment is used. From this measurement, power and energy consumption of electrical appliances and equipments can be obtained.

Finally, from measurement of those electrical appliances and equipments, only some appliances and equipments will show the significant impact to the energy consumption in domestic and commercial sectors. Therefore this information will be used for further analysis.

4. Result and Analysis

4.1 Ownership of Electrical Appliances and Equipments

The distribution of electrical appliances and equipments ownership in domestic and commercial sectors are shown in Fig. 3 and Fig. 4 respectively.

The ownership of electrical appliances in domestic sector are differs for different residential classes, Fig. 3. Respond from the respondents, the most popular electrical appliances owned by domestic consumers are lamp, washing machine, refrigerator, television, rice cooker, iron, fan and blender. These electrical appliances are owned by more than 40 consumers for each residential class. This result indicates that those electrical appliances are major load in domestic sector. Domestic consumers in Setapak and Wangsa Maju consider that those electrical appliances are necessity to comfort their daily life. Some domestic consumers concern that some electrical appliances are not important for example kettle and rice cooker. It is because they prefer to use conventional method to cook the rice and boil the water rather than using electric appliances. Other obvious example, they prefer of using fan rather than air conditioner for air ventilation and cooling. This is indicates that, some consumers are really concern in consuming electricity, i.e. they only consume when they really needed. Therefore, this is good sign in consuming electricity wisely and efficiently. Initially it is already started.

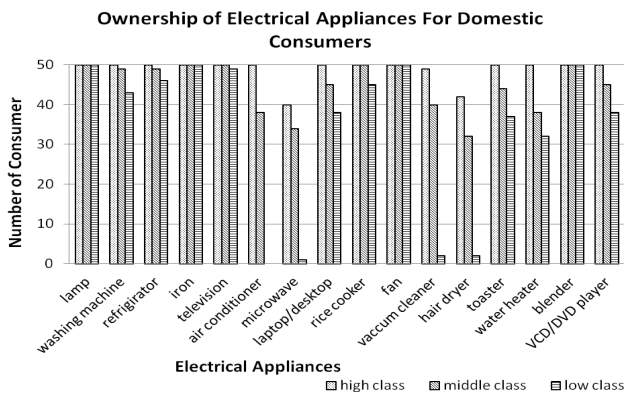


Fig. 3 Ownership of electrical appliances in three residential classes

The ownership of electrical appliances and equipments in commercial sector is differs for different type of the sector, Fig. 4. Most of light appliances almost are similar to the domestic consumers. However, the critical electrical appliances and equipments owned by commercial consumers are refrigerator/freezer, compressor, air-conditioner, drill machine and saw machine. These electrical appliances and equipments are critical because it consumed huge amount of electricity. This indicates that those electrical appliances and equipments are heavy loads in commercial sector and they really need it for survival of their business.

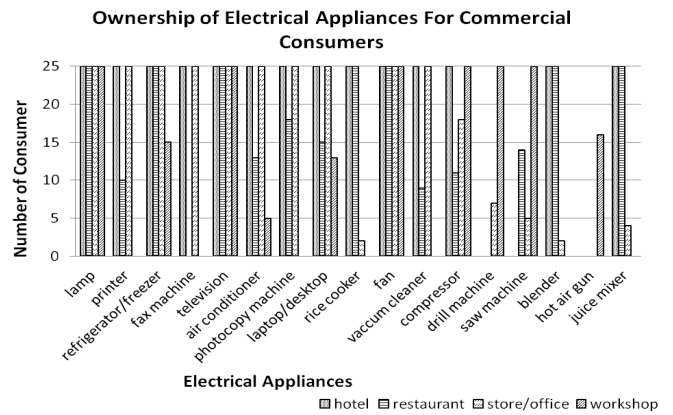


Fig. 4 Ownership of electrical appliances in four typical commercial sectors

4.2 Power Consumption Pattern Profile for Domestic and Commercial Sectors

The power consumption profile for electrical appliances for domestic sector is shown in Fig. 5. It shows that the peak hour electricity consumption is between 7.00 am to 9.00 am and from 7.00 pm to 10.00 pm. This data is collected on Friday, 18th November 2011 at one of the sample house at Wangsa Maju area during weekdays. More than 5 kWh amount of electricity energy have been consumed during weekdays for one house. If 5 kWh are considered average daily consumption, a year is about 1,820 kWh for single house. By considering the usage of efficient appliances and wisely usage, the consumption amount can be reduced at significant amount.

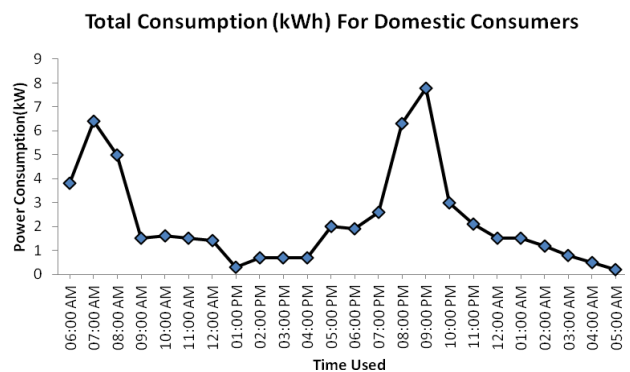


Fig. 5 Usage pattern profile of electrical appliances for domestic consumer

Fig. 6 shows power consumption profile for electrical appliances and equipment for commercial sector. In commercial sector, the sample considered only for 1 workshop at Sri Rampai area and the data is collected on Friday, 18th November 2011. It shows the peak hour for using this workshop operated is between 10.00 am to 6.00 pm. At this time, the electricity consumption is more than 10 kWh a day. If this amount

is considered daily average consumption, a year is about 3,640 kWh. Workshop usually uses heavy and critical load, such as drill, air compressor and arc welding. These types of loads will consume huge of electricity. Therefore by the usage of high efficient of equipments, the consumption amount can be reduced drastically.

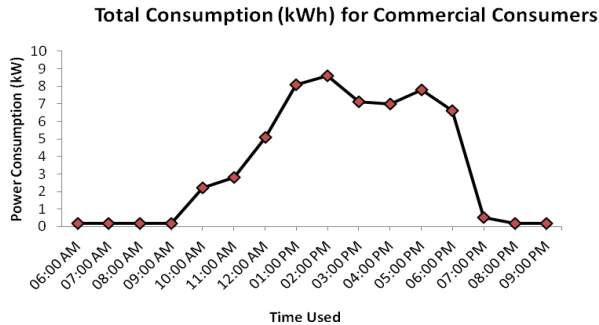


Fig. 6 Usage pattern profile of electrical appliances and equipments for commercial consumer

4.3 Electricity Energy Consumption at Three Residential Classes in Domestic Sector

From the survey, the electricity consumption and monthly cost per household can be approximately calculated as shown in Table 1. The calculated cost is based on TNB tariff rates. The samples are picked from Wangsa Maju and Setapak residential areas for a double storey house, single storey and apartment (*Projek Perumahan Rakyat Termiskin*). The estimation usage is 30 days a month.

It is obvious that high class consumers used heavy loads as compared to the low class consumers. For high class consumers they considered air-conditioner, water heater and high capacity refrigerator as needed appliances.

Table 1 Electricity energy consumption for three types of residential classes in domestic sector

Types of Residential	Consumption (kWh)	Cost (RM)
High class	443.06	134.31
Medium class	404.64	118.87
Low class	260.4	63.77

4.4 Electricity Energy Consumption in Commercial Sector

Table 2 shows electricity consumption and monthly cost for four types of commercial consumers. The electricity consumption can be approximately calculated as shown in Table 2. The calculated cost is based on TNB tariff rates, Tariff B - Low Voltage Commercial Tariff and over 200 kWh usage monthly. The samples are picked from Sri Rampai commercial areas for a small

hotel, small restaurant, small store/office and small workshop. The estimation usage is 30 days a month.

Small hotel consumed the highest electricity as compared to other commercial consumers. Usually heavy loads in a hotel are air-conditioners, compressors, water heaters and electric stoves. These loads will consume high of electricity energy, it needed for business operation. If energy saving strategy is practiced, monthly electricity consumption can be reduced drastically. However, in order to replace all existing with high efficient appliances and equipments, it needs high costs, not all of them afford for that. Therefore most of commercial consumers just use existing appliances and equipments. This situation mostly happened to the commercial consumers.

Table 2 Electricity energy consumption in commercial sector for four types of commercial sectors

Types of Commercial	Consumption (kWh)	Cost (RM)
Hotel	979.89	421.35
Restaurant	472.44	228.95
Store/Office	504.91	217.11
Workshop	649.59	279.32

4.5 Electrical Appliances and Equipments Measurement Using Power Quality Analyzer Equipment

Table 3 shows the details data obtained from measurement process using power quality analyzer equipment. It only involved on selected appliances and equipments. The appliances and equipments are measured during sometimes operation.

For domestic sector, iron, computer (PC), rice cooker and refrigerator are selected. While for commercial sector, compressor, circular saw, drill and hot air gun are selected.

Based on the measurement process, it shows that refrigerator consume the highest electricity as compared to other appliances. The electricity consumption for medium small size refrigerator is about 108 kWh a month and the total cost of operation for refrigerator is about RM 23.54. While in commercial sector, the air compressor equipment consumed the highest electricity follow by hot air gun. It consumed about 268 kWh in a month and the total costs of operation are RM 115.48 and RM 51.60 respectively in a month and it depends on frequency of used. Therefore, it shows that refrigerator, hot air gun and compressor among of the appliances and equipments that consumed very high of electricity energy.

If those appliances and equipments that consume high electricity energy are replaced by high efficient energy consumption types, electricity consumption can be reduced drastically. However, in term of cost usually high efficient appliances and equipments are expensive than typical or conventional types.

Table 3 Data measurement using power quality analyzer equipment on selected appliances and equipments; (a) residential selected appliances, (b) commercial selected equipments

(a)

Type of Appliances	Refrigerator	Rice Cooker	Computer (PC)	Iron
Power Rated (kW)	0.3	0.65	0.12	1.1
PF	0.51	0.99	-0.49	1
kWh	0.021	0.05	-0.022	0.205
Estimation of Electricity Consumption (30 days/kWh)	108	19.5	28.8	16.5
Unit Cost	RM 0.218			
Operation Cost (RM)	23.54	4.25	6.28	3.6

(b)

Type of Appliances	Air Compressor	Circular Saw	Drill	Hot Air Gun
Power Rated (kW)	2.238	1.05	0.35	2
PF	0.67	0.94	0.87	0.72
kWh	0.112	0.034	0.008	0.021
Estimation of Electricity Consumption (30 days/kWh)	268	31.5	21	120
Unit Cost	RM 0.43			
Operation Cost (RM)	115.48	13.55	9.03	51.6

5. Conclusion

The consumer’s electricity consumption pattern profile plays an important role in determining the effectiveness of controlling the energy consumption of particular electrical appliances and equipments. The use of high efficient and efficiently appliances and equipments are able to manage electricity consumption and potential savings for electricity in domestic and commercial sectors.

By referring the findings, some strategies can be proposed in utilizing electricity wisely and effectively. First strategy, it is important to start with change consumers’ behavior and habit in utilizing appliances and equipments wisely and effectively. Therefore those appliances and equipments only operated when it needed

only, otherwise those appliances and equipments need to be turn off. Second strategy, consider high efficient appliances and equipments, for instances, buy appliances with Energy Star Label approved.

Therefore, by concerning those important parameters, behavior and technology, electricity consumption can be managed wisely and effectively. Therefore it needs systematic and holistic approaches from government to consumers.

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