" I hereby declare that I have read through this report entitle "Home Energy Controller" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature : …….....

Supervisor's Name : Puan Junainah Binti Sardi

Date : ……...

HOME ENERGY CONTROLLER

MUHAMAD MUZAKKIR BIN BASAR @ SABTU

A report submitted in partial fulfillment of the requirements for the degree

Of Bachelor of Electrical Engineering (Power Industry)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2013

I declare that this report entitle “Home Energy Controller” is the result of my own research except as cited in the reference. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……

Name : Muhamad Muzakkir Bin Basar @ Sabtu

Date : ……

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Assalamualaikum w.b.t

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A**BSTRACT**

Home Energy Controller can help to control the electrical device operation and reduce the energy consumption during peak hour. The electrical devices operations based on time peak-hours and non-peak hours. The electrical devices only operate non-peak hours because in the peak-hour electricity consumption is high. During peak hour (8.00am-10pm) energy consumption is high because many electrical devices operate for this time. The main objective of this project is to develop a prototype of Energy controller for domestic load home system, and to reduce energy during peak hour. The Home Energy Controller can control the operation of the load to be operated only during the off peak hours. The controller principle is based on an automatic time load shifting for control the electrical device. The load is equipped with a sensor. The expected result is home energy controller for doing home device is build and energy consumption during peak hour can be reduced.

ABSTRAK

Tenaga Pengawal Rumah boleh membantu untuk mengawal operasi peranti elektrik dan mengurangkan penggunaan tenaga pada waktu puncak. Alat-alat elektrik beroperasi berdasarkan masa puncak dan bukan puncak. Alat-alat elektrik ini hanya beroperasi bukan waktu puncak kerana penggunaan elektrik pada waktu puncak adalah tinggi. Pada waktu puncak (8:00am-10:00pm) penggunaan tenaga adalah tinggi kerana banyak alat-alat elektrik beroperasi pada masa ini. Objektif utama projek ini adalah untuk membangunkan prototaip Pengawal Tenaga untuk sistem rumah beban domestik, dan untuk mengurangkan tenaga pada waktu puncak. Tenaga Pengawal Rumah boleh mengawal operasi beban supaya beroperasi pada masa bukan puncak. Beban ini dilengkapi dengan sensor. Operasi pengawal ini berdasarkan masa automatik beban beralih. Hasil dijangka adalah pengawal tenaga di rumah digunakan untuk menjalankan peranti rumah dibina dan penggunaan tenaga semasa waktu puncak dapat dikurangkan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Electricity consumption is increasing every year. It can be seen based on the increment of residential and commercial sectors as well the industrial sector [4]. Therefore, the utility company should provide enough electricity to supply the demand of consumers to avoid all their activities is disturbed. Users must be wise in managing energy to avoid wastage. It is because to provide the electricity, utility company consumes more cost especially during peak hours.

Home energy controller is developed to control the use of electricity at home especially during peak hours. There are a variety of equipment used in the home such as washing machines, water heaters, lighting, fans and others.

Home Energy Controller consists of three parts. The first part is the time. This part is design to ensure that this system will operate during non-peak hours. The second part is the sensor, which functions to detect objects on the electrical equipment and then send the signal to microcontroller to operate the electrical equipment at non-peak hours. If sensor cannot detect object, the electrical equipment cannot operate. The third part is the electric meter that works to calculate the electricity consumption at peak and non-peak hours.

1.2 The Project Motivation

The main purpose of developing this project is due to the unawareness of electricity user about the high wastage of electricity. High wastage of electricity or high usage of electricity can cause a bad situation to environment. The next reasons are to help user to control their electricity so that they can control their monthly electricity bill. Some user has awareness about their usage of electric energy at their home, but they did not know how to manage or control their usage. So, by using this project, it can help user to control their electricity usage by controlling their appliance operation at home. Furthermore, these projects also include the display of real time energy usage which is a very helpful to user for reducing their usage.

Using high electricity energy during the peak hour or period can cause high demand of electricity. The consequence of high demand of electricity is, the utility company need to provide enough electricity to support the demand. To produce high electricity, it will cost a lot.

Lack of civic consciousness is also one of these project motivations. Nowadays, people are lack of electricity knowledge. They just know how to turn on or off their electricity appliance without knowing the total energy that consume by the appliance. Thus, it may result the high wastage of electricity, next will result the increasing their electricity bill. So, by using this project, user can know the total energy that the appliances consume.

1.3 Problem Statement

The daily electrical energy consumption at home is not constant. During peak-hour the level of electrical energy consumption is higher compare to non-peak hour. Therefore the cost is to provide the energy is also higher. Although energy consumption during peak hour diverted to non-peak hour the energy consumption will still remain the same. However the cost to provide the energy production can be reduced [2]. Automatic time shifting of the load operation need to be done to reduce the consumption of energy during peak hours. The development of Home Energy Controller can schedule operation of load. This will reduce the energy consumption during peak hours and delay the energy usage automatically after peak hour.

1.4 Objective

The objectives of this project are:-

1. To develop a prototype of Home Energy Controller for domestic load home system
2. To reduce energy consumption during peak hour
3. To evaluate the performance of the controller in term of its flexibility and accuracy

1.5 Scope of Project

The scopes of this project are:-

1. The Home Energy Controller can be applied to control the home appliance.
2. The prototype of Home Energy Controller is tested for 2 loads only.
3. The controller principle is based on an automatic time load shifting for electrical device operation.
4. Home Energy Controller can be operate manual and auto mode
5. The meter can be read only in Watt hours (wh)
6. Time peak and non-peak have been fit (peak 8am-10pm, non-peak 10pm-8am)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes the literature review. Literature review discuss about the theory taking from sources such as journals, books, previous paper and internet. It will explain more about the project made.

2.2 Energy

Energy is the ability to do the work. There are a variety of energy available on earth. These energies can be used to get a better life. Therefore, as human must be wise to use energy properly. Most of energy produce from the fuel and produce heat. This heat energy can be used in system mechanical energy that create motion against some form of mechanical resistance [5]. One of important energy for human is electricity. The figure 2.1 shows the percentage of energy demand by sector in 2010 provided by Pusat Tenaga Malaysia 2010 [5].

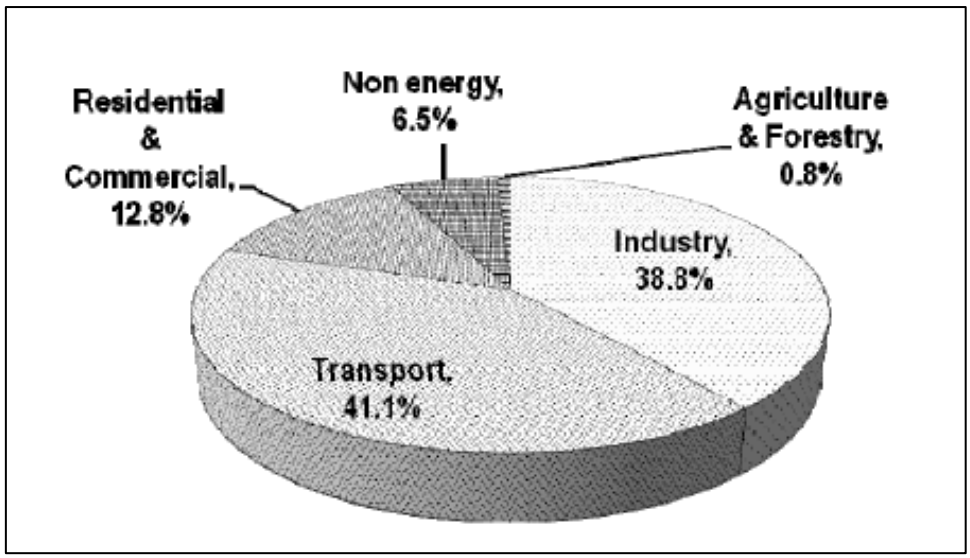

Figure 2.1 : Final Energy Demand by sectors in 2010 [5]

2.2.1 Typical Domestic Load in Malaysia

The figure 2 below shows one of the residence load profile of electrical appliances for domestic consumer in Malaysia on 2012. It taking the data through questionnaire about the type of electrical equipment that is used, the length of time the equipment usage and bill payment in a few months [5]. Based on the load profile of electrical appliances for domestic consumer show about energy consumptions in 24 hours or 1 day. There are two peak times of usage at 7:00 am until 9:00 am and 7.00pm until 10.00pm. During weekdays the energy consumption increases around 5kWh. Therefore the daily average in year is 1820kWh [5].

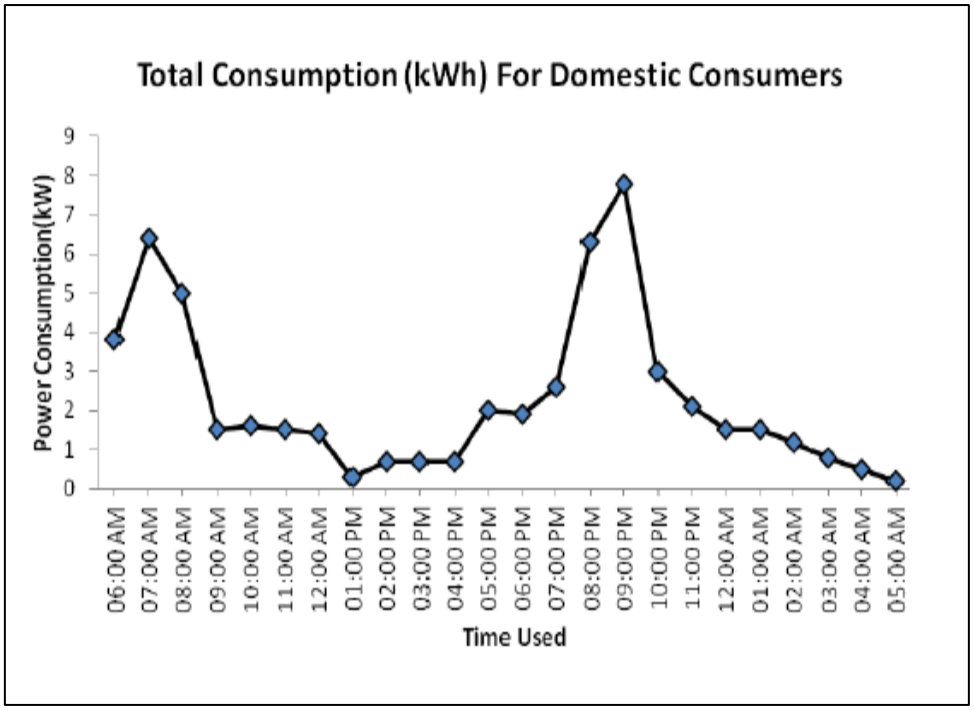

Figure2.2: Load Profile of electrical appliances for domestic consumer [5]

2.3 Previous Related Works

This part would explain about the research that has been done by those earlier focuses on construction of the Home Energy Controller.

2.3.1 Implementation and Evolution of the Apparatus for Intelligent Energy Management [1]

There is available related research done by In-Ho Choi, Joung-Han Lee, Seung-Ho Hong present Korea 2011 [1] on the Implementation and Evaluation of the Apparatus for Intelligent Energy Management apply to the smart grid at home. The purpose of this project is promoting the smart grid system for effective energy saving [1]. There are three components necessary to monitor and control energy consumptions which are smart controller, AMI (Advance Metering Infrastructure) and EMS (Energy Management Server). Smart controller which install in the electrical appliances will capture energy amount use and calculate electrical consumption on real time basic. The utility company use AMI to check the amount of energy consumption on consumer's meter and use this information to build a pricing system. There are three pricing system which are TOP (Time of Pricing), CPP (Critical Peak Pricing) and RTP (Real Time Pricing) [9]. As a result the consumers will try to reduce the amount of energy consumption especially during peak period and therefore energy can be achieved [7][8]. EMS will provide the reports for AMI and smart controller [6].

The smart controller design consists of hardware and software design. The hardware design comprises analog and digital part [1]. The analog consist of power supply, energy metering and switching relay, meanwhile the digital consist of microprocessor, wireless and wired communication interface. The software design is comprises of main loop and operation software [1]. The software design is the programming to operate the smart controller.

Experiment has been done to prove that smart grid system is useful in energy saving. Three type of illumination with different type of watts are used in this experiment. The result of the experiment in table 2.1 shows that the energy will be reducing to 67% when the smart grid with smart controller is used [1]. Thus, there are 33% of energy and corresponding prices were saved as well [1].

In conclusion, the proper monitoring of energy consumption from smart grid system eventually will promote energy saving. It also gives an advantage for the user to control their utilities bills for using the pricing systems introduce by the utilities company through information in the AMI.

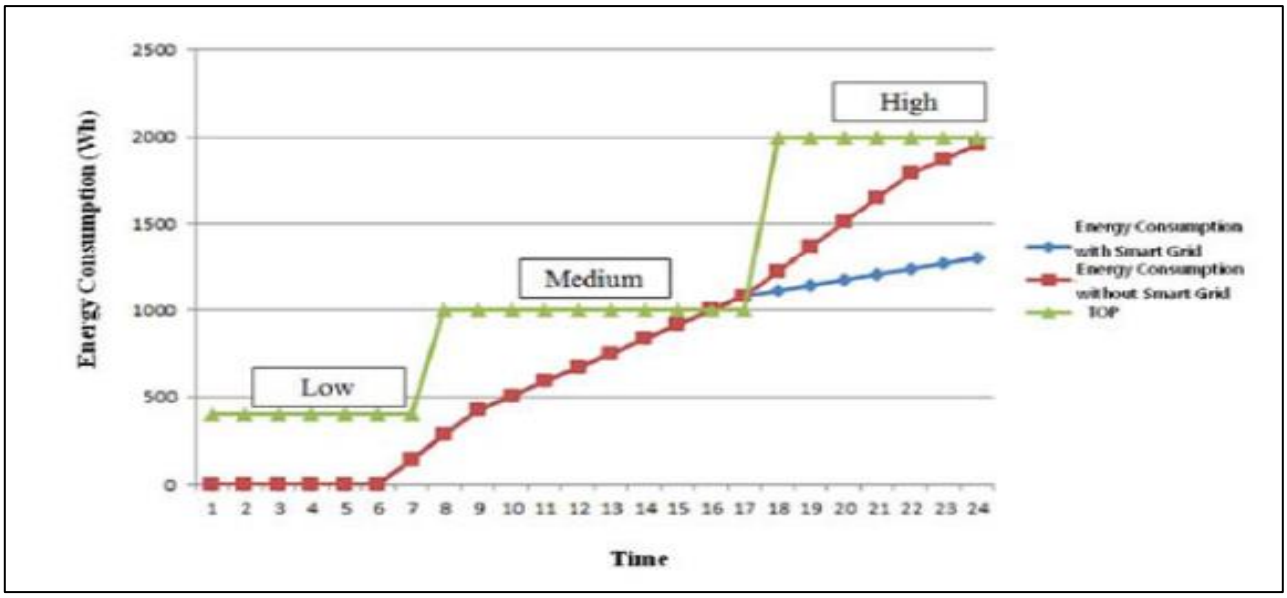

Figure 2.3: The result of energy consumption in Demo [1]

Table 2.1: Compare Of Energy Consumption [1]

Type	Daily cumulative energy consumption	Time interval of illumination usage (hours)			Saving rate
		Inc.lamp	Hal lamp	Flu.tube	
Ilumination control with smart grid	1306Wh	0	9	18	67%
Ilumination control without smart grid	1956Wh	9	18	18	100%

2.3.2 Smart Plug for Building Energy Management Systems [2]

There is available related research done by Hamed Morsali, Seyed Mohammad Shekarabi, Kamyar Ardekani, Hossein Khayami, Alireza Fereidunian, Mona Ghassemian, Hamid Lesani present Tehran, Iran [2] on the Smart Plugs for Building Energy Management Systems. The purpose of this paper is to investigate the functionalities of smart plug in providing the measurement of energy consumption and recognizes the type of attached electrical devices [2]. Beside that it can be used to monitor the performance of data centers and assist in the assessment of energy monitoring. The advantages of using smart plug are lower implementation cost and have ability to measure and record energy consumption instantly. Furthermore, it can measure the quality parameter of consumer appliances.

This paper also present the framework for smart plug to do remote monitoring, appliances type recognition and switching method. There are four subsystems in this framework which are recognition, switching, measurement and communication [2]. Recognition systems, is where the appliances type being recognize using magnetic sensor. Switching subsystem is where the appliances being switch on/off using power triac. Measurement a subsystem is where the voltage and current is being calculated to measure energy quality and consumption using CT sensor. A communication subsystem is where the data on voltage and current is being transmitted using RS-485 bus either through wireless or wire communication technologies.

When smart plug connected to the device, it will determine the types of appliances using magnetic sensor and at the same time calculates the energy usage and energy quality. All the encoded data will be sending to the processing unit for monitoring decision making and data storage. Based on these data, the central controller will then, and send commands to switch each specific plug on/off depending on the energy management program via communication links. This is the overall process for the framework of smart plug mention in this paper. [2]

The conclusions of the analysis show the positive result. When using the smart plug, the peak usage was reduced by 22% compare to without smart plug [2]. This based on the experiment on the pilot house in Tehran, Iran [2].

Table 2.2 : Implementation Result [2]

	Cost		Total Usage (kWh)	Standard deviation $s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{N-1}}$	Peak Usage (kW)
	TOD method	Tehran (winter)			
Without smart plugs	395	195	10.75	185	1.07
With smart plugs	357	186	10.75	306	0.837
Impact rate	-10%	-4.5%	0%	+65%	-22%