



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND DEVELOPMENT OF A SMART HOME POWER
MONITORING SYSTEM FOR ENERGY AWARENESS USING ARDUINO**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

.....

(EMY ZAIRAH BINTI AHMAD)

ABSTRAK

Tujuan projek ini adalah untuk meningkatkan kesedaran pengguna mengenai penjimatan penggunaan tenaga. Pada hari ini, peningkatan dalam suhu permukaan global menyebabkan beberapa kawasan di dunia menjadi lebih panas kerana peningkatan pelepasan karbon dioksida. Salah satu faktor yang menyebabkan peningkatan pelepasan karbon dioksida adalah loji janakuasa konvensional yang menggunakan arang batu, gas dan bahan api perlu menghasilkan tenaga elektrik yang lebih banyak berikutan peningkatan penggunaan tenaga elektrik oleh pengguna. Untuk mengatasi masalah ini, sistem pemantauan kuasa rumah pintar akan direka. Sistem ini akan membantu pengguna untuk meningkatkan kesedaran tenaga di rumah dengan memaparkan kos elektrik (RM) dan pelepasan karbon dioksida (Kg) di atmosfera. Sistem ini juga akan dilengkapi dengan sistem penggera untuk memberi amaran kepada pengguna apabila ia mencapai had penggunaan tenaga.

ABSTRACT

The aim of this project is to increase the awareness for consumer about saving energy consumption. Nowadays, increasing in the global surface temperature causing some areas of the world become warmer due to increasing of the emission of carbon dioxide. One of the factor that cause to increasing of the emission of carbon dioxide is conventional power plant that use coal, gas and fuel need to produce more electricity due to increasing of the electrical energy consumption by consumer. To overcome this problem, the smart home power monitoring system will be developed. This system will help consumer to increase energy awareness at home by displaying the electricity cost (RM) as well carbon dioxide emission (Kg) in the atmosphere. The system also will be equipped with alarm system to alert user when it reaches energy consumption limit.

DEDICATION

I want to dedicate this report to those who have supported, helped and assisted me throughout this report. Especially to my beloved family, honourable lecturers and friends for all their guidance and attention to me until finish of this report.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

%	-	percent
CO ₂	-	Carbon Dioxide
GaAs	-	Gallium arsenide
GaAsP	-	Gallium arsenide phosphide
GaP	-	Gallium phosphide
Kg	-	Kilogram
Ktoe	-	Kilotonne of oil equivalent
kWh	-	Kilowatt hour
LCD	-	Liquid Clear Display
LED	-	Light Emitting Diode
RAM	-	Random-access memory
RF	-	Radio frequency
RM	-	Ringgit Malaysia
ROM	-	Read-only memory
TNB	-	Tenaga Nasional Berhad
UART	-	Universal Asynchronous Receiver/Transmitter
Wh	-	Watt-hour

CHAPTER 1

INTRODUCTION

1.1 Introduction

An energy meter is a device to measure the electrical energy consumption (kWh) by either domestic consumer or commercial consumer. There are two types of energy meter, electromechanical meter and electronic meter. As the improvement has been continuously made by researcher, a smart energy monitoring system has been introduced. This system has feature more advanced technology than both types of energy meters due to it can measure and display not only electrical energy consumption but also electrical bill and percentage of carbon dioxide emission.

Tenaga Nasional Berhad (TNB) is the electricity utility company in Peninsular Malaysia. TNB is responsible for the generation, the transmission and the distribution of electricity. They also install and maintain the energy meter at house, factory and company building. TNB is in charge of the pricing and tariff of electricity to the consumer based on their electrical energy consumption.

1.2 Problem Statement

Mostly, consumer know their electrical energy consumption at the end of each month through electricity bill. This method has disadvantages for consumer as they did not aware of their electrical energy usage which will affect their electricity bill. According Felix Teo Soon Heng (2016), 12 from 100 respondents have their average monthly electricity bill above RM 200. This may due to waste of electricity usage and lack of energy saving awareness.

Increasing in electrical energy consumption lead to increasing of energy maximum demand. Thus, conventional power plant that use coal, gas and fuel need to produce more electricity to fulfil the demand. This will increase the emission of carbon dioxide to atmosphere causing global warming. Global warming is a phenomenon related to current increasing in temperature of the Earth surface and atmosphere.

1.3 Objectives

The objectives of this project are:

- i. To design and develop a smart home power monitoring system for energy awareness.
- ii. To test the functionality of the system when electricity is used.
- iii. To analyse cost of electricity used and the amount of carbon dioxide released by consumer when electrical appliances are power up at home.

1.4 Work scope

The project work scopes are:

- i. Study on theoretical calculation of cost of electricity used and the amount of carbon dioxide released based on electricity use.
- ii. Design and development a smart home power monitoring system that can displayed the electricity cost (RM) as well carbon dioxide emission (Kg) in the atmosphere and alert user when it reaches energy consumption limit

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is a study or analyse about a certain data that have been collected through various sources. In this chapter, literature review has been done by analysing the information from articles, journals, internet and books. This chapter is divided into two parts. The first part is a review of past projects. The next part is an overview of software and hardware that will be used in the project such as microcontroller, circuit breaker and buzzer.

2.2 Review on Past Projects

2.2.1 Digital Household Energy Meter (Nor'aisah Sudin, Mohd Zeid Abu Bakar and Mohd Helmy Abd Wahab, 2008)

This project developed a digital electrical pricing system which composed of three elements. Those elements are an interval meter capable of register energy consumption in a specified period of time, a communication system that upload usage data from the meter to a central computer for data processing and a display panel on the computer which display the real-time pricing to the user. The authors used Mk 6 Genius as the meter. EziView interfacing software was used to configure the connection. RS-232 interface of computer was directly connected with the meter. Then, the computer will display the electrical consumption price through display panel.

This project could produce the cost (RM) based on the energy use. The system will update the value for every second and each month, the cost reading is automatically recorded.

For the future, providing more accurate meter reading in the terms of pricing unit, the focus can be changed by developing the system to the user in industrial sector, commercial community and the government itself.

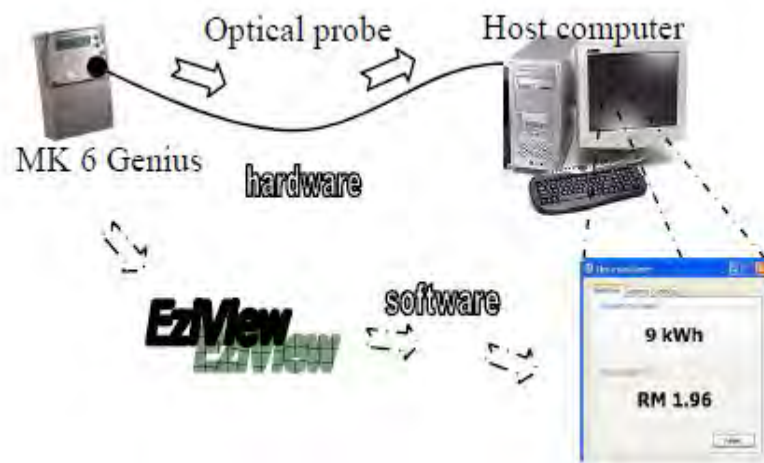


Figure 2.1: System process (Nor'aisah Sudin, Mohd Zeid Abu Bakar and Mohd Helmy Abd Wahab, 2008)

2.2.2 Design and Development of Home Energy Monitoring System Using PIC for Energy Consumption Awareness (Felix Teo Soon Heng, 2016)

Using PIC16F887, the input came from electric power meter. The microcontroller received data from electric power meter through light sensors by detecting LED pulse signal. As the microcontroller collects data, the LCD will display the cost (in RM) and emission carbon dioxide (in kg) based on the energy data collected. Beside LCD display, Bluetooth module was also connected to the microcontroller. This module received data from microcontroller and sent it to computer through Bluetooth that enable user to monitor the energy information in the house.

The result of this project was shown in the LCD display by showing the cost (RM) and energy (kg) based on the load use. The comparison between theoretical calculation and result of analysis was almost same but the error percentage was get higher as the reading value getting higher.

This project has a little problem. The limitation number of execution in microcontroller is not enough for all coding command needed. The conversion of float significant number by microcontroller effected the accuracy of meter reading.

As for recommendations, the author suggested to use bigger microcontroller or Arduino to replace the existing microcontroller. The alarm system can be implemented to alert user whenever the energy consumption exceeds the limit.

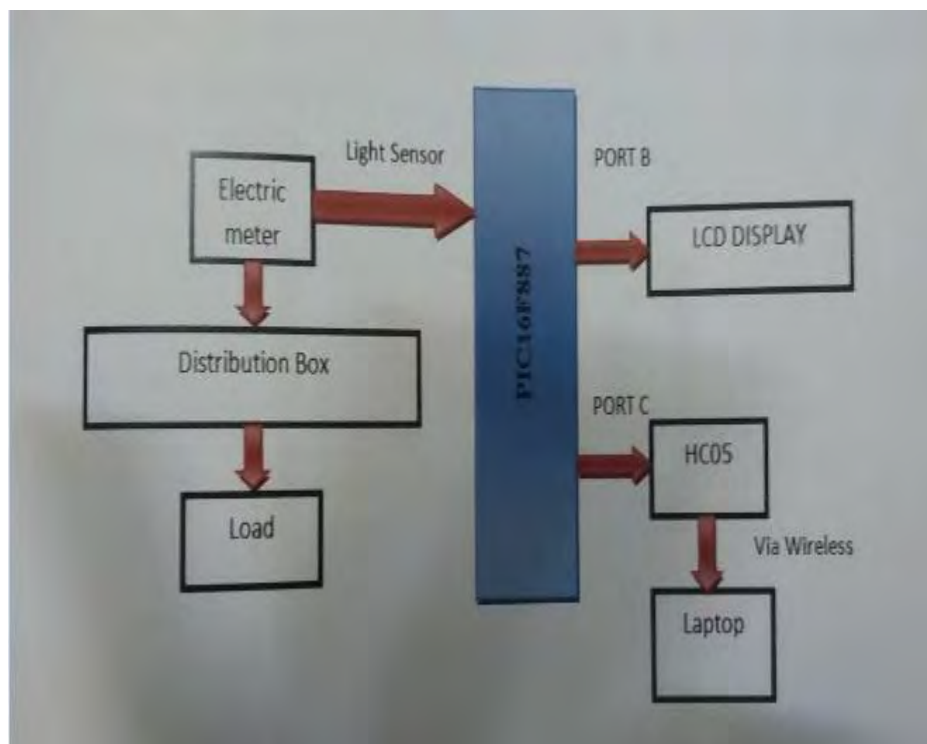


Figure 2.2: General block diagram of project (Felix Teo Soon Heng, 2016)

2.2.3 Automated Controlling of Smart Meters (Chaithra Pallavi D and Suman M, 2015)

This project developed the smart meter to collect and store the energy consumption data at regular intervals and allows two-way communication between the utility provider and user. This project consists of three main parts which are electrical meter, processing unit and communication module. Electrical meter for energy measuring convert the energy data to the data that can be interpreted by the processing unit for monitoring purpose. Processing unit is functioning to process and record the data from meter for controlling and monitoring the meter and communication unit. The communication unit can be implanted within the smart meter or in extension slot. By using low module radio frequency (RF), the smart meter transmit data to the data concentrators to collect and send the data to the central meter data management. Relay ON/OFF in the smart meter will control the power connection based on their period of payments.

This meter has avoid manually reading meters. The faster response times, real time recording of energy consumption data and accurate billing can avoid the disruption in the service. For the future, this project can be done by triggering the user regarding their energy usage and remaining prepaid balance.

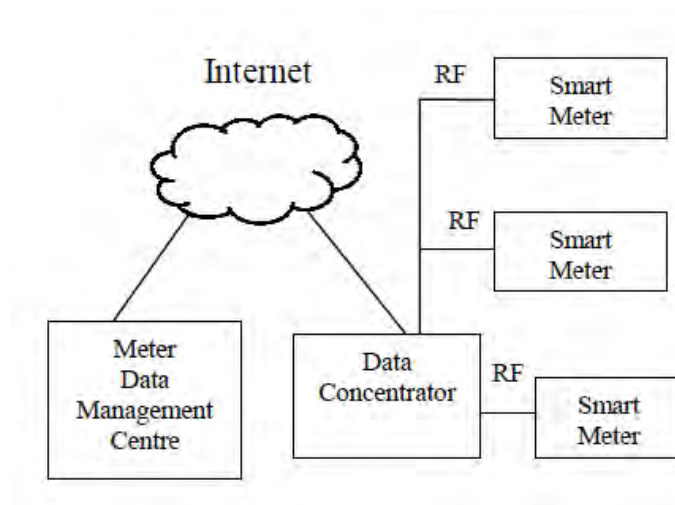


Figure 2.3: Communication model (Chaithra Pallavi D and Suman M, 2015)

2.3 Energy Meter

Energy meter is a device that measure the amount of electrical energy consumed by a domestic consumer or a commercial consumer (Subhasis Maitra, 2016). This device is used by utility company to collect the energy consumption used and produce bill. Basically, there are two types of energy meters namely electromechanical meter and electronic meter (Subhasis Maitra, 2016). Theoretically, this device records the energy consumption (kWh) used based on power consumption (kW) over the period usage (hour).

$$\text{Energy (kWh)} = \frac{\text{Power (kW)}}{\text{Time usage (hours)}}$$



Figure 2.4: Electronic meter (Source: <<http://www.spectrose.com/energy-meters-what-are-they-and-how-they-works.html>> 12/4/2017)





Figure 2.5: Electromechanical meter (Source: <<https://www.engineersgarage.com/contribution/electronic-energy-meter>> 12/4/2017)

2.3.1 Electronic Meter

As the latest technology, electronic meter had been widely used. It is able to display the energy consumption by LCD or LED display. It can also record other parameters such as reactive power and power factor. Electronic meter has a power supply, metering engine, a processing microcontroller, communication modules and others add-on modules such as RTC and RS 232 ports. Electronic meter can be divided into two: single phase and three phase electronic meter. The meter contains a pulsing visible red LED for power consumption monitoring. For single phase type, one pulse equals to 1 Watthour (Wh). While three phase type, 200 pulse correspond to 1 kWh.

Table 2.1: Electronic meters that are used by TNB (TNB, 2014)

Type	Model	
Single Phase		KMSB (Krizik Malaysia Sdn Bhd) Model: EIS
		MIM (Malaysia Intelligence Meters Sdn Bhd) Model: G3