# Development of Energy Meter for Smart Metering Application

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## 1. Introduction

In recent years, the amount of $CO_2$ is increasing due to excessive use of energy such as from the burning of fossil fuel and the electric power demand also increase from year to year. Thus, it is necessary to improve the power management by enabling the smart energy management system with the implementation of smart metering application. It can help users to decrease both energy costs and amount of energy supply. In order to achieve this, it is vital to arrange for intelligent switching off of unnecessary loads during peak periods [1]. The purposes of this study are to develop energy measurement module in smart meter and to enable a smart-energy management system that helps users to decrease both energy costs and amount of the energy supply. In this system, the need of monitoring and automation of switching on and off is necessary. Thus, the energy meter and temperature and humidity sensor is also applied in the smart metering application to measure the energy of the appliances and detect the surrounding temperature and humidity.

## 2. Smart Metering Application

### 2.1 Smart Meter

The current conventional energy meter only provides one-way communication which is conducting manual collection of data and the billing will be done by the consumers manually. However, with the development of technology, smart metering system is introduced which provides two way communications between the meter and utility. Figure 1 shows the data process of a smart meter. By having the smart metering system in a building, the loads can be controlled anywhere by the consumer to cut the electric cost. The detection of temperature and humidity is one of the examples of the function in smart metering system to enable the automatic switching off of the appliances inside the building. Besides, the current retailed product in the market have the smart plug with temperature and humidity sensor that need to be connected separately with the plug. A built in sensor in the smart plug is also one of the aim of this research.

### 2.2 Smart Plug

On the market nowadays, two types of smart plug are available which are external and built in. External smart plug is in the form of device where placed between the wall power outlet and the appliance's power cord. Meanwhile, the built-in smart plug is invisible since it is integrated into the wall outlet itself. Based on analysis made in [2], many external smart plug systems are available on the market nowadays and only small amount of built in smart plug is exist.

With the rapid development of Wi-Fi technology, smart plug can secure the compatibility with other portable devices besides the guarantee on the power efficiency. The main requirements on the development of smart plug are compactness, low power used, easy integration, increased security and low price.

Even though smart plug is connected with Wi-Fi, the users cannot control the power usage efficiently since it is hard to get the information and data from the used applications. The users will not know at what point the power supply should be cut off since there is no measuring method to collect the data of power usage. By implementing smart meter in the smart plug, the smart plug can be controlled remotely with high effectiveness since the users will know the usage data.

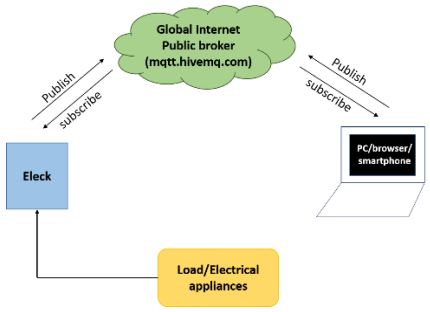


Figure 1 Data process of a smart meter

## 3. Proposed Design

The proposed design used HLW8012 as the energy meter to measure the power, voltage and the current. Besides, DHT11 humidity and temperature sensor is also added to the smart meter.

Figure 2 shows the configuration of the smart metering

application. The measured data from the energy meter and the sensor can be used for several applications. The data from the energy meter can be used to monitor the power usage of the home appliances. The measured data by the sensor can be used as the reference for the user to control their home appliances. Other than that, the temperature and the humidity data also can be used to switch on or off the air- conditioner.

Thus, by having these applications in the smart meter we can control our home appliances and save the electricity bill.

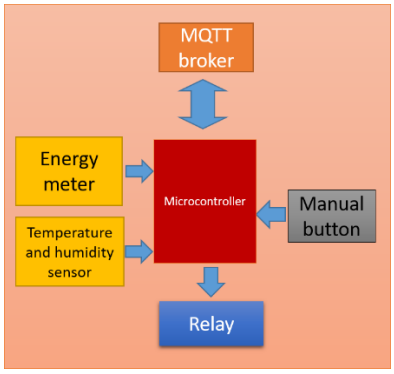


Figure 2 Configuration of the smart metering application

## 4. Experimental Test

The experiment is to measure the power, voltage and current by using HLW8012 energy meter and detect the temperature and humidity of surrounding by using DHT11 sensor.

Figure 3 shows the experimental circuit of the smart metering application. The energy meter and the temperature and humidity sensor are connected to the ESP8266 Node MCU which acts as the microcontroller. Two types of load are used which are 90W/100V and 80W/100V light bulb. The measured data then will be displayed in the MQTT lens. MQTT stands for Message Queuing Telemetry Transport. It is a lightweight publish and subscribe system where publish and receive messages as a client can be done.

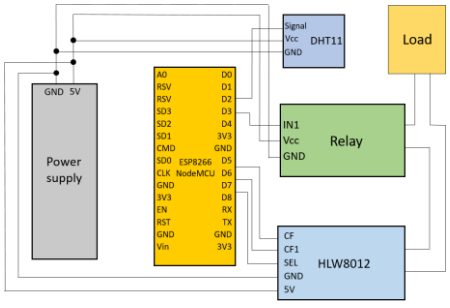


Figure 3 Experimental circuit of smart meter

## 5. Results

Figure 4 shows the results of measuring temperature and humidity in MQTT broker by using DHT11 sensor. It is shown that the sensor is able to measure the temperature and the humidity. The temperature measured by the sensor also is the same as the real-time temperature. In figure 5, the measurement result of power, current, voltage, temperature and humidity is shown in MQTT lens. The results show the same value with the fixed power, voltage and current.

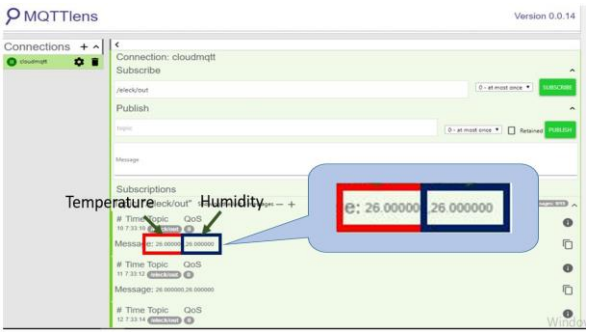


Figure 4 Measured data of temperature and humidity displayed in MQTT lens

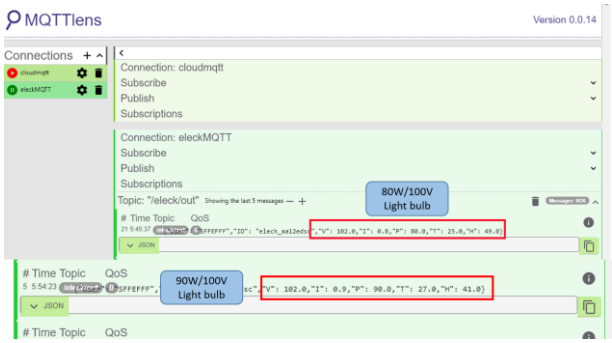


Figure 5 Measured data of in MQTT lens

## 6. Conclusion and Future Works

From the experiment, the data from the energy meter and temperature and humidity sensor can be read successfully. In the future, the measured data from the energy meter and sensor can be used for many applications in order to reduce the electricity cost. Moreover, a smaller smart plug also should be designed so it can fit into the socket plug that is available in the market. In conclusion, by having this mart metering application in a building, it can help in conserving energy.

References

[1] P. Dongbaare, S.O. Osuri and SP Daniel Chowdhury, "A Smart Energy Management System for Residential Use", *IEEE PES-IAS PowerAfrica*, 2017.

[2] Brenkus, J.; Stopjakova, V.; Zalusky, R.; Mihalov, J.; Majer, L.; Radioelektronika (RADIOELEKTRONIKA), 2015 25th International Conference, 21-22 April 2015.