Contents:

IoT based Smart Energy Meter

Abstract:

Smart meters are essential to efficient energy consumption and play a key part of the smart grid infrastructure. Smart meters will help consumers stay fully informed about their daily energy use and eliminate wasteful routines or get rid of inefficient appliances. For utility companies, the real-time visibility into energy consumption process translates into accurate billing data and the ability to balance demand against supply via flexible pricing and other policies. With the IoT Platform, smart meters can be easily implemented to support these and many other smart grid features.

Real-time smart home/smart building energy profile

User apps for billing data accounting

Smart metering over HVAC, consumer electronics, and industrial equipment

Smart meter networks

Smart meter data analytics

Fault detection

Theft detection

INTRODUCTION:

Monitoring and keeping track of our electricity consumption is a tedious task today both for consumers and electric distribution companies since we need to go to each household meter reading room and take down readings. Well it is important for companies to issue bill and for us to know if we are charged accordingly so the need is quite certain. This billing system is very slow and laborious can cause lots of error in billing.

Well we automate the system by allowing users as well as utility company to monitor energy meter readings over the internet. Our proposed system uses energy meter with microcontroller system to monitor energy usage using a meter. The meter is used to monitor units consumed and the rate at which unit is being consumed (i.e., power) and transmit this data as well as cost charged over the internet using Wi-Fi connection. This allows user to easily check the energy usage along with the cost charged online using a simple web application. Thus the energy meter monitoring system allows user to effectively monitor electricity meter readings and check the billing online with ease.

Advantageous to the consumers:

i) Can set the monthly electricity billing budget.

ii) No need to wait for the month end bill.

iii) They know exactly how much power is being utilized.

iv) Efficient use of energy.

Advantageous to the utility:

i) Less labor cost. There is no need of human operator to go to the consumers address to take down the reading.

ii) Remote access of the meter reading.
iii) Optimum generation cost, raw material, losses and hence increase in revenue

LITERATURE SURVEY AND RELATED WORKS

For measuring the usage of the consumption of energy electronic meter or electromechanical meter is fixed in existing system. Currently the meters take the recording kWh units. There are many AMR systems which are based on Bluetooth, GSM technology. But in these technology continuous and global access is not possible. By combining Internet of Things we can have wide range of possibilities over the above outdated and slow technologies. As internet is becoming cheaper and cheaper now a days and world is moving toward IoT, we think that IoT enabled Energy Meter will be a game changer.

HARDWARE:

Single phase digital energy meter

The conventional mechanical energy meter is based on the phenomenon of "Magnetic Induction". It has a rotating aluminium Wheel called Ferriwheel and many toothed wheels. Based on the flow of current, the Ferriwheel rotates which makes rotation of other wheels. This will be converted into corresponding measurements in the display section. Since many mechanical parts are involved, mechanical defects and breakdown are common. More over chances of manipulation and current theft will be higher.

Electronic Energy Meter is based on Digital Micro Technology (DMT) and uses no moving parts. So the EEM is known as "Static Energy Meter" In EEM the accurate functioning is controlled by a specially designed IC

called ASIC (Application Specified Integrated Circuit). ASIC is constructed only for specific applications using Embedded System Technology. Similar ASIC are now used in Washing Machines, Air Conditioners, Automobiles, Digital Camera etc.

In addition to ASIC, analogue circuits, Voltage transformer, Current transformer etc are also present in EEM to "Sample" current and voltage. The 'Input Data' (Voltage) is compared with a programmed "Reference Data' (Voltage) and finally a 'Voltage Rate' will be given to the output. This output is then converted into 'Digital Data' by the AD Converters (Analogue- Digital converter) present in the ASIC.

The Digital Data is then converted into an "Average Value". Average Value / Mean Value is the measuring unit of power. The output of ASIC is available as "Pulses" indicated by the LED (Light Emitting Diode) placed on the front panel of EEM. These pulses are equal to Average Kilo Watt Hour (kWh / unit). Different ASIC with various kWh are used in different makes of EEMs. But usually 800 to 3600 pulses / kWh generating ASIC s are used in EEMs. The output of ASIC is sufficient to drive a Stepper Motor to give display through the rotation of digits embossed wheels. The output pulses are indicated through LED. The ASIC are manufactured by Analogue Device Company. ADE 7757 IC is generally used in many countries to make EEMs. ADE 7555 / 7755 ASIC maintains the international standard CLASS I IEC 687/ 1036.

Arduino pro mini

The Arduino Pro Mini is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable or Sparkfun breakout board to provide USB power and communication to the board.

The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions.The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino.

Microcontroller	ATmega328
Board Power Supply	3.35 -12 V (3.3V model) or 5 - 12 V (5V model)
Circuit Operating Voltage	3.3V or 5V (depending on model)
Digital I/O Pins	14
PWM Pins	6
UART	1
SPI	1
I2C	1
Analog Input Pins	6
External Interrupts	2
DC Current per I/O Pin	40 mA
Flash Memory	32KB of which 2 KB used by bootloader *
SRAM	2 KB
EEPROM	1 KB
Clock Speed	8 MHz (3.3V versions) or 16 MHz (5V)

Wi-Fi module ESP8266

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all conditions.

Opto-isolator IC

In electronics, an opto-isolator, also called an optocoupler, photocoupler, or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 25 kV/μs.

A common type of opto-isolator consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp-photoresistor pairs. Usually opto-isolators transfer digital (on-off) signals, but some techniques allow them to be used with analog signals.

Electronic equipment and signal and power transmission lines can be subjected to voltage surges induced by lightning, electrostatic discharge, radio frequency transmissions, switching pulses (spikes) and perturbations in power supply. Remote lightning strikes can induce surges up to 10 kV, one thousand times more than the voltage limits of many electronic components. A circuit can also incorporate high

voltages by design, in which case it needs safe, reliable means of interfacing its high-voltage components with low-voltage ones.

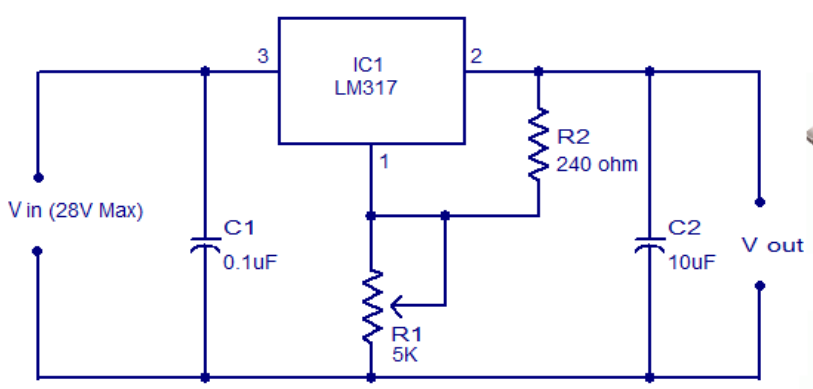
The main function of an opto-isolator is to block such high voltages and voltage transients, so that a surge in one part of the system will not disrupt or destroy the other parts. An opto-isolator connects input and output sides with a beam of light modulated by input current. It transforms useful input signal into light, sends it across the dielectric channel, captures light on the output side and transforms it back into electric signal. Unlike transformers, which pass energy in both directions with very low losses, opto-isolators are unidirectional and they cannot transmit power. Typical opto-isolators can only modulate the flow of energy already present on the output side. Unlike transformers, opto-isolators can pass DC or slow-moving signals and do not require matching impedances between input and output sides

LM317 voltage regulator

The LM317 is an adjustable 3−terminal positive voltage regulator capable of supplying in excess of 1.5 A over an output voltage range of 1.2 V to 37 V (3.3v in our case). This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, it employs internal current limiting, thermal shutdown and safe area compensation, making it essentially blow−out proof.

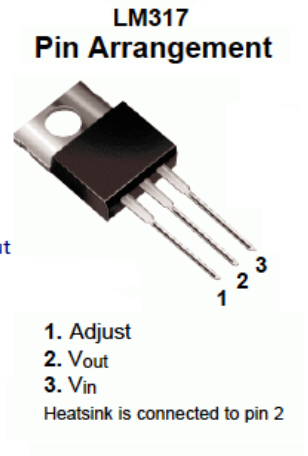
The LM317 serves a wide variety of applications including local, on

card regulation. This device can also be used to make a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM317 can be used as a precision current regulator.



Typical adjustable regulator using LM317 www.circuitstoday.com

Vout = 1.25V (1+ (R2/R1)) + (I adj x R2)



SOFTWARES

Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

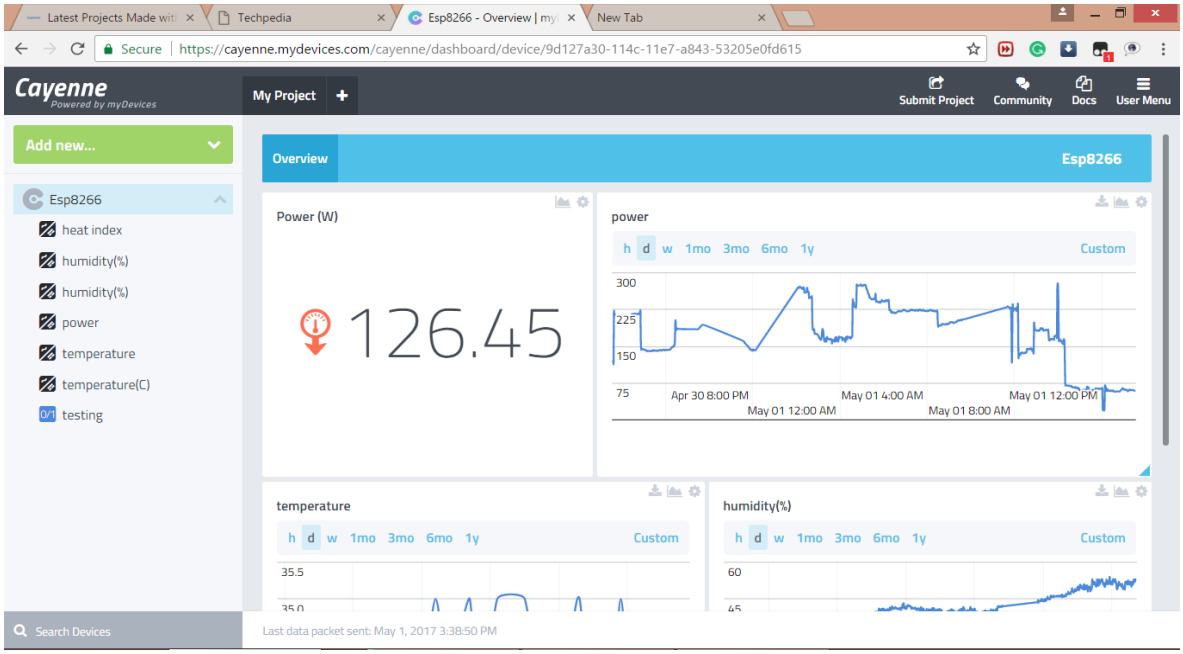
Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The

toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

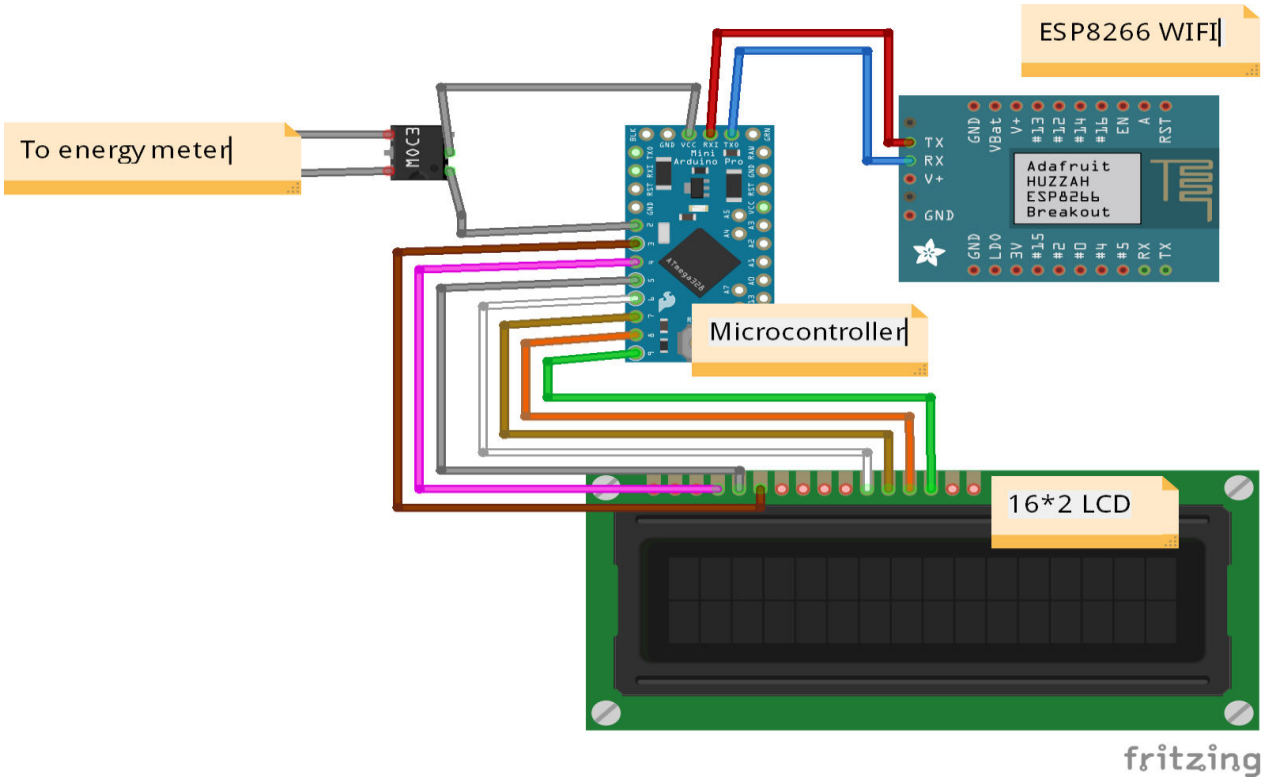
IoT Platform “mydevice”

mydevice cayenne is a open source Internet of Things platform which allows user to collect and display data in a web page or mobile application. Apart from it is also allow user to set threshold of data, events, graph, in a very interactive use interface

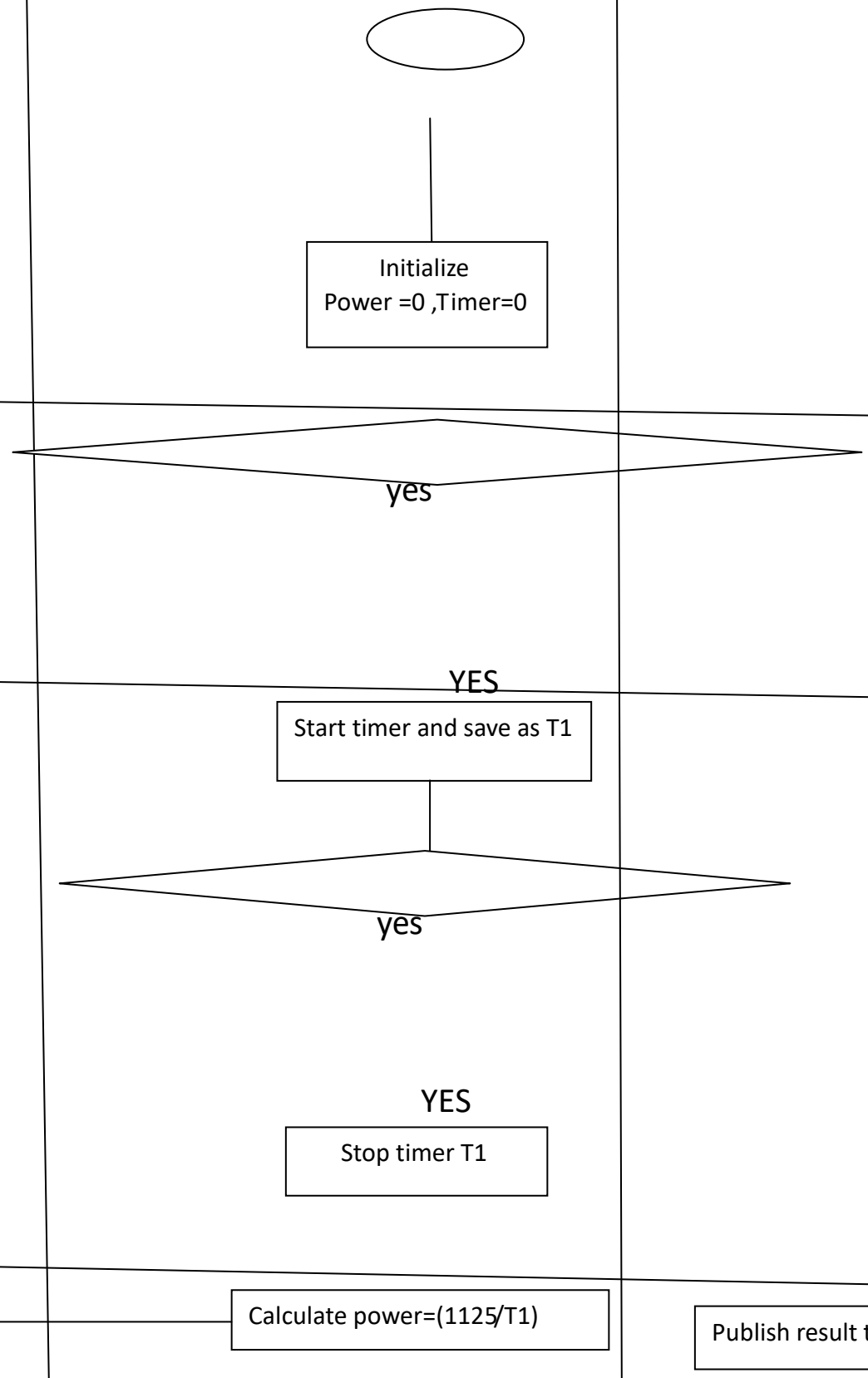
USER INTERFACE



CIRCUIT DIAGRAM


ESP8266 WIFI
To energy meter
Microcontroller
16*2 LCD
Adafruit
HUZZAH
ESP8266
Breakout
fritzing

FLOW CHART


Initialize
Power =0 ,Timer=0
yes
YES
Start timer and save as T1
yes
YES
Stop timer T1
Calculate power=(1125/T1)
Publish result to web

CODING:

Arduino pro mini

energy_meter_dedicated_pro_mini | Arduino 1.8.4

File Edit Sketch Tools Help

energy_meter_dedicated_pro_mini §

```
#include <SoftwareSerial.h>
SoftwareSerial swSer(2,3);
float duration;
int timeout=100000;
float power1;
unsigned long power;
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
void setup()
  {
  swSer.begin(9600);
  }

void loop()
          {
          duration = pulseIn(pin, LOW, timeout);
          power1=(1125/duration)*1000000;
          power=power1*100;
          swSer.print(power+100000);

          }
```

ESP8266 Wi-Fi module

CONCLUSION AND FUTURE SCOPE

Everyone, from consumers to corporates, is embracing the changes brought by the revolution called the Internet of Things (IoT). It has changed the world in more ways than we could imagine until a few years back. And the changes and advancements will continue in future as well, in fact, Internet of Things (IoT) will shape our future.

Smart meters will be essential to efficient energy consumption and will play a key part of the smart grid infrastructure. Smart meters will help consumers stay fully informed about their daily energy use and eliminate wasteful routines or get rid of inefficient appliances and hence will help in conservation of resources. It will help utility companies to have real-time visibility into energy consumption and accurate billing data and the ability to balance demand against supply via flexible pricing and other policies. With the IoT Platform, smart meters can be easily implemented to support these and many other smart grid features.

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c) **Mydevice.cayenne: IoT platform**

d) **Arduino.cc.org**

e) **www.ti.com/VoltRegulator/LM317**

f) **github.org**

g) **https://github.com/esp8266/Arduino**