

Internet of Things based Smart Energy Meter

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Abstract— The interest for power has expanded exponentially over last century. The system has been structured dependent on the use of Smart Energy Meter to read energy units consumed and to get a precise reading for user with the assistance of PZEM-004T. In the event if there is over use of power by user, ready message will be send to user. Rustic regions will have lot of power cut issues so the arrangement is proposed in this paper such that , Smart Energy Meter will measure power used and will be sent as message to power grid stations through Thing speak server which helps for load balancing . So Smart Energy Meters are utilized to get precise reading of power units, diminish the energy utilization in households and sent message to power grid stations which helps in load balancing.

Keywords—Smart Energy Meter, Node-MCU, PZEM 004T.

1. INTRODUCTION

India is the 0.33 biggest maker of electricity on the earth and stands fourth biggest inside the Energy utilization. The electrical energy wolfed through the horticultural region was recorded 17.89% in 2015-sixteen among all nations. Not with status less luxurious Energy responsibility in India, the per capital electricity utilization is low in comparison with several nations.

The electricity age limit in India is surplus however the first-rate foundation for offering energy to each penniless individual is poor. So as to accumulate the system to deliver satisfactory Energy to all of the destitute people inside the state via March 2019, the authorities of India propelled a plan called "electricity for all". This plan will assure nonstop and continuous Energy supply to all corporations, family units, and enterprise foundations with the aid of enhancing vital machine. It is a joint obligation by the government of India with states to proportion subsidizing and make by means of and large improvement of the financial system.

The electricity division in India is commanded through petroleum merchandise, mainly coal, which brought around 66% of all electricity in the year 2016. In any case, simply the speculation of sustainable energy supply is improved by the government. The Draft country wide power Plan of 2016 arranged with the aid of the government of India expresses that the state needn't trouble with greater nonrenewable energy flowers in the software place until 2027, with the dispatching of fifty,0.5 MW coal-based totally force plant life underneath development and undertaking 275,000 MW absolute added inexhaustible force restriction.

India was the 1/3 biggest maker of power on this planet with 48% of worldwide provide. Out of the all-out energy produced the renewable Energy source comprised for about 28.43% and the non- renewable Energy supply adorned for Energy is the essential prerequisite for having an agreeable life. It is to be accurately utilized and overseen. At gift, the human operator from the electricity Board visits the resident to take the readings from the power meter and creates the invoice for the specific month manually.

The notion is being proposed to decrease the human impedance to accumulate the month to month perusing and to restriction the specialized problems with respect to the charging technique. From the Energy board segment, the facts with appreciate to the invoice sum, installment and the pre-planned Energy close down facts are imparted to the patron. Within the occasion that the consumer doesn't contend with the invoice in time, the consumer is educated via a message utilizing IoT. On the off chance that also the person would not take care of the invoice, at that factor in keeping with assigned concept, one alarm message may be dispatched at that point clearly electricity connection is disconnected from the far off server.

It gives pre-intimation of Energy cut subtleties and moreover the power usage on normal time table. It gives a warning if the electricity utilization surpasses beyond as a ways as viable. It moreover has the office of finishing the Energy supply through a message while the occupants are out of station to limit the wastage of power. It is a success approach for more noteworthy precision, stepped forward charging. In apartments, the energy meter is a long way far

from the inhabitants. A liquid crystal display show is put in every personal house to educate about the messages with admire to the energy reduce, power utilization on regular schedule, charging subtleties and a warning for as a long way as possible signal.

Energy meter charging is a sizeable piece of power movement. On every occasion an man or woman is required from the energy to accumulate the perusing of meter and make a invoice to the buyer. Be that as it can, this made an trouble in light of the truth that the guide perusing wishes hard work, tedious and can cause a blunder. Alongside those strains, exceptional energy meter goals giving the offices of programmed perusing of meter and furthermore can become aware of the meter hardening by sending the message with the help of IOT. It moreover can understand the flaw if happens inside the electric system over- burdening and caution the consumer of over-burden use of Energy by using sending the message. This transformer empowers the power division to peruse the meter perusing month to month without character journeying each domestic. This can be completed through utilization of Arduino unit that continuously records the perusing of energy meter, its nonvolatile memory area.

This machine can likewise be utilized to disengage the energy supply of home when required. This paper basically manages awesome power meter, which uses highlights of the hooked up machine for example a mix of device and programming. The paper talks approximately how and what type of work is completed by way of IOT based savvy energy meter. Likewise with the assistance of Wi- Fi Modem the customer can screen its wolfed perusing and may set facet an incentive through the page. Within the occasion that the patron would not recognize approximately edge observe, at that factor meter receives off evidently after that purchaser can increase the edge worth and meter will therefore activate. At long ultimate, the general month to month bill with sum might be dispatched to the patron just as a consultant co-op of content material from the outset day of continuously.

2. LITERATURE REVIEW

[1]. The paper entitled as "**Implementation of Wi Fi-Based Single Phase Smart Meter for Internet of Things (IoT)** ", in 2017 by the creators Win Hlaing, Somchai Thepphaeng, Varunyou Nonbilloot, Natthanantangsunantham, Tanayoot Sangsuwan, Chaiyod Pira.

The authors have center fundamentally around IoT's electricity looking at. The proposed plan is to execute an exceedingly ease far off sensor gadget and conference for savvy electricity and net software prepared to do naturally perusing the unit and sending the facts therefore for the Energy clients to look their present Energy meter perusing. by using making use of this system, the customers will recognize approximately the power usage in his/her domestic to reduce the power wastage and price of utilization.

The proposed device can live on and enhance the problems of power effectiveness and reasonability. The parameters of Energy meter can be perused correctly and dependably, as an instance, load profile, request esteem, and the all out electricity usage. For IoT usage attitude, the WiFi module ESP 8266 works dependably with the quit purpose that it is able to ship the facts to reveal on the web site during the current server. In outline, we will accomplish the notably high dependability automatic energy meter readily, and it thoroughly may be observing absolutely like popular electricity meter. Our proposed machine can likewise be done with much less inconveniences ventures with ESP8266 WiFi module set up into the meter with the TCP/IP conference for empowering interchanges among the meter and net software. The destiny works will do not forget the presentation improvement for phrases of modify identifications and blackout warnings.

The advanced strength meter accommodates of Arduino Leonardo seasoned Micro - 5V/16MHz that's the principle work for ascertaining the meter parameter, for instance, current, voltage, power in kW, kVAr, and energy in kWh and kVarh. the existing sensor of the meter can paintings with the restrict of 30 Ampere, and it's far supposed to be successfully utilized with miniaturized scale controllers, just like the Arduino. This gift sensor machine ACS712 can supply extraordinarily minimum effort solutions for AC modern detecting for correspondence structures.

The advanced electricity meter incorporates of Arduino Leonardo pro Micro - 5V/16MHz that is the fundamental capacity for ascertaining the meter parameter as shown in Fig 1 , as an example, modern, voltage, strength in kW, kVAr, and energy in kWh and kVarh. The present sensor of the meter can paintings with the restriction of 30 Ampere, and it's far intended to be correctly applied with miniaturized scale controllers, just like the Arduino.

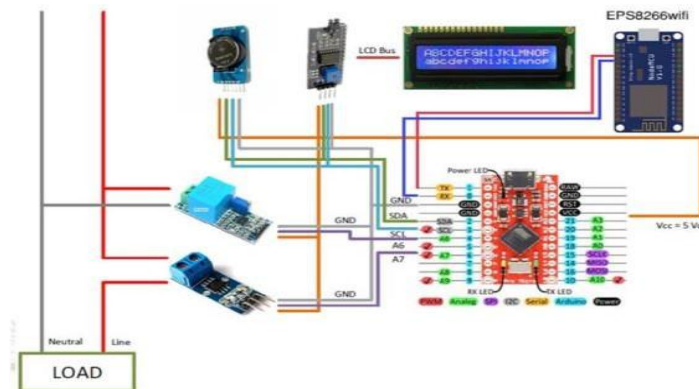


Fig 1: Digital energy meter's architecture with ESP8266 wifi module.

This present sensor device ACS712 can provide minimal effort answers for AC present day detecting for correspondence systems. This machine package takes into account easy execution, specially the programs comprise burden location and the executives, replacing mode strength elements, and over modern-day shortcoming insurance. The single degree voltage sensor unit is ZMPT 101B extremely miniaturized scale voltage transformer with supply voltage of 5VDC, sign yield of easy and little length with excessive precision, brilliant consistency for voltage and strength estimation. The sensor module voltage has 250VAC AC most extreme signal from a simple signal module. It tends to be associated with the microcontroller's ADC pin utilized promptly as Vref + 5V Arduino Leonardo. The continuous clock module DS3231 is an exceedingly minimal effort with amazingly unique I2C Realtime clock (RTC). It's far an included temperature-remunerated treasured stone oscillator (TCXO) and gem. The system carries a battery enter, and continues up genuine timekeeping when essential capacity to the machine is intruded. The check can paintings in both the 24-hour or 12-hour organization with an AM/PM marker. There are programmable time- of-day cautions and programmable square-wave yields are given. Deal with and records are moved sequentially through an I2C bidirectional transport. The 16x2 lcd display module can painting sixteen characters in 2 line display with dark content at the green foundation. The liquid crystal display has registers for order and statistics.

[2].The paper entitled as "**IoT based smart energy meter** ", in 2018 by the creators Amrita Singh, Ravi Gupta

The proposed gadget intended to dispose of human contribution inside the power gadget. IOT (internet of things) is the machine of physical matters with hardware programming, sensors, and network to empower articles to acquire and trade statistics. IOT primarily based programmed meter perusing is the innovation of programmed accumulating facts electricity meter and transferring records to the server for charging process and within the event that there is any hardening, at that point additionally perceivable. The net associated with meter accumulate the facts and show data on the liquid crystal display by using which we are able to peruse and comprehend the matters that are going on the gadget. contemporary drawn moreover determined through the present transformer that related in association with the heap will be seemed on the lcd. This facts flow to reduce off unit at MSEB. MSEB is whatever but a specialized phrase but it is electricity dissemination board "Maharashtra kingdom electricity Board". The data is got through the net and at anything factor a secret is squeezed microcontroller send SMS through the web to the transmitter to get the perusing of the meter. It's far hard to guide perusing and computing invoice of solely. This may help for the best feasible and genuine perusing of charging system. Via taking each such a highlights that must be possible by means of IOT based totally eager power meter effectively.

Energy meter charging is a enormous piece of strength move. Whenever an individual is needed from the strength to collect the perusing of meter and make a bill to the customer. Be that as it is able to, this made an trouble in light of the reality that the manual perusing needs exertions, tedious and can reason a mistake. In this manner, savvy electricity meter goals giving the places of work of programmed perusing of meter and furthermore can distinguish the meter treating by sending the message with the help of IOT. It moreover can distinguish the flaw if takes place within the electric device over-burdening and warning the customer of over-burden usage of strength with the aid of sending the message. In this microcontroller unit, liquid crystal display, sensors, cutting-edge sensor and Voltage sensors are to be used. In this proposed machine we supplant the commonplace meter by using a metering module which accommodates metering IC and microcontroller tests the energy meter clearly after continually and transmit to the buyer and suggest

professional co-op device as proven in Fig 2. This stores information sends SMS to the patron approximately the charging sum and likely if a few other sports occur on this proposed device, as an instance, hardening, over-burdening, deficiency and so forth. IOT is most effective the wellspring of correspondence among patron and expert co-op for example internet Server.

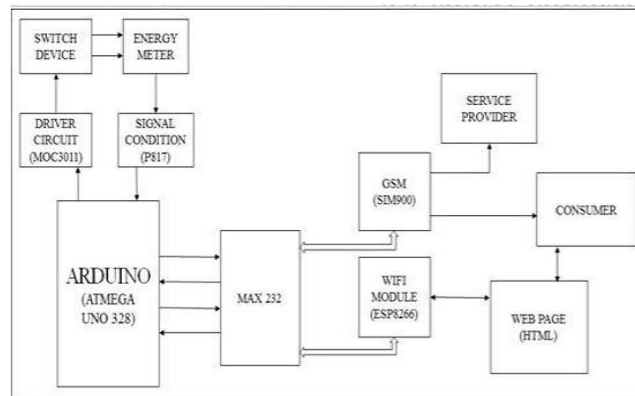


Fig 2: Block diagram of IOT based energy meter

IOT is the overall system for the information move over and the constantly online association between primary area and cell phones. The expense of moving information is a lot lesser than the SMS. 8051 microcontroller is interfaced with energy meter and PICF877A which goes about as the primary controller with the assistance of RS-232. In this system power supply is given to energy meter. A GSM unit shows the interfacing with the microcontroller. Information move to office MODEM utilizing client MODEM. Every single shopper has extraordinary number given by the power.

[3]. The paper entitled "**Smart Energy Meter Surveillance Using IoT**", in 2018 by the creators Anitha.K and Avitha.V

The principal goal of this paper is to make mindfulness about energy utilization and productive utilization of home apparatuses for energy reserve funds. Because of manual work, our current power charging system has significant downsides. This system gives the data on meter perusing, power cut and the ready systems for delivering an alert when energy utilization surpasses past as far as possible utilizing IoT. This thought is being actualized to lessen the human reliance to gather the month to month perusing and limit the specialized issues with respect to charging process. This task broadens the structure and usage of a energy observing system with the pre-hint of intensity motivation utilizing Arduino small scale controller and a GSM (Global System for Mobile Communication) module.

The upside of this system is that a client can comprehend the power devoured by the electrical apparatuses on the regular schedule and can find a way to control them and along these lines help in energy preservation. From the power board area, the data with respect to the bill sum, installment and the pre- arranged power shut down subtleties are conveyed to the shopper. In the event that the client doesn't take care of the bill in time, the client is educated through a message. In the event that still the client doesn't take care of the bill, at that point according to assigned thought, one alarm message will be sent at that point consequently power association is separated from the remote server. In the previously existing shrewd energy meter, it shows the energy devoured by the apparatuses from the date of embellishment of the energy meter and its comparing rupees. In this proposed energy meter, the meter gives the energy expended on consistent schedule, its comparing rupees, charging subtleties and installment utilizing IoT.

Furthermore, it has the fundamental target of giving the preintimation of intensity plan and a ready system for delivering a caution when the energy utilization surpasses past as far as possible. It additionally has the office of ending the power supply when the inhabitants are out of station to limit the wastage of energy as shown in Fig 3. This system not just decreases the power cut issues and the work cost for seeing the private energy utilization in standard interims yet in addition builds the energy preservation with the assistance of alert systems and the energy meter exactness by lessening the charging mistake. The current model is a tedious procedure and it needs a ton of work. The proposed system wipes out the need of work and it is a cost proficient and an efficient procedure.

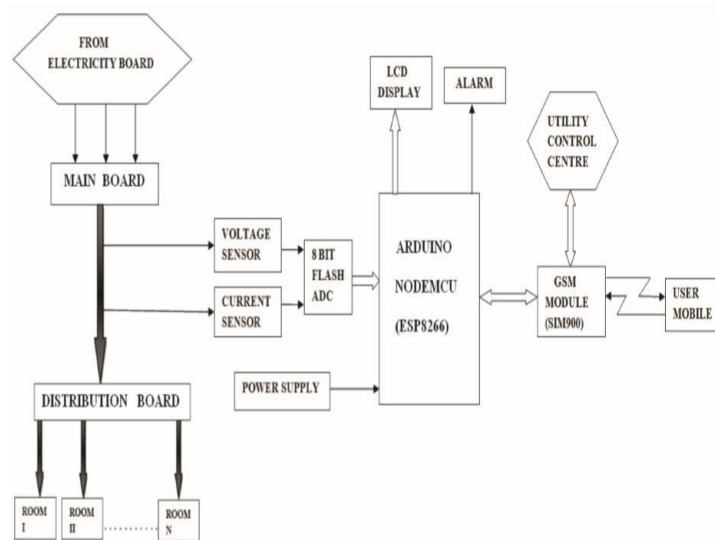


Fig 3: Functional block diagram of the Hardware module

The proposed system gives the data about the energy utilization on everyday schedule, charging and installment through IoT, pre-suggestion of shut down subtleties, ready systems when the energy utilization surpasses past as far as possible and the disengagement of intensity through a message when the private are out of station to forestall the wastage of energy.

3. METHODOLOGY

In this microcontroller unit, LCD, sensors, current sensor and Voltage sensors are available. In this proposed system we replace the customary meter by a metering module which comprises metering IC and microcontroller checks the energy meter naturally after consistently and transmit to the buyer and propose specialist organization system as shown in Fig 4. This stores information sends SMS to the buyer about the charging sum and perhaps if some other exercises occur in this proposed system, for example, tempering, overloading, fault and so on. IOT is nothing but the source of communication between consumer and service provider i.e. Web Server. The expense of moving information is a lot lesser than the SMS. 8051microcontroller is interfaced with Node MCU and PZEM- 004T goes about as the main controller with the assistance of RS-232. In this system user can comprehend the power consumed by the electrical apparatuses on the regular routine and can find a way to control them and hence help in energy preservation. The measure of energy expended, that information is sent as SMS to the Power grid stations through server which will assist us with knowing the measure of energy consumed by specific city and to take care of power cut issues.

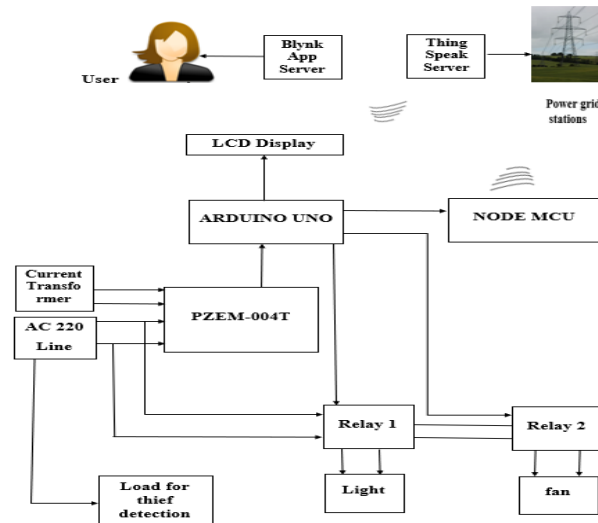


Fig 4: Block diagram of IOT Based Smart Energy Meter.

COMPONENTS SELECTION

Hardware Requirements

- AVR ATMEGA328Microcontroller
- Node MCU ESP8266 Wi-Fi Controller Board
- PZEM 004T Power Meter With Case
- Battery
- LCD Display(20*4)
- RelayModule
- Android Mobile

Software Requirements

- ArduinoIDE
- BLYNK Application

NODE MCU ESP8266:

Core processor ESP8266 in littler sizes of the module typifies Tensilica L106 coordinates industry-driving ultra low power 32-bit MCU micro , with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, underpins the RTOS, incorporated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna as appeared in Fig 5. The module supports standard IEEE802.11 b/g/n agreement, total TCP/IP convention stack. Clients can utilize the add modules to a current gadget systems administration, or building a different network controller.



Fig 5 : Node MCU ESP8266 Controller

ESP8266 is high integration wireless SOCs, intended for space and power obliged versatile stage creators. It gives superb capacity to insert Wi-Fi abilities inside different systems, or to work as an independent application, with the most reduced expense, and insignificant space necessity. The ESP8266 is the name of a smaller scale controller structured by Espressif Systems. The ESP8266 itself is an independent WiFi organizing arrangement offering as a scaffold from existing smaller scale controller to WiFi and is additionally equipped for running independent applications.

AVR ATMEGA328:

The Atmel® ATmega328P gives the accompanying highlights: 32K bytes of in-system programmable flash with read-while-write abilities, 1K bytes EEPROM, 2K bytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented 2-wire serial interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable watchdog timer with internal oscillator, and five software select able power saving modes as shown in Fig 6. The idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire serial interface, SPI port, and interrupt system to continue functioning.



Fig 6: AVR ATMEGA328 Microchip Controller.

The Microcontroller is the heart of the system. In this project, Arduino UNO development board is used. The features of this board are:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40mA
- DC Current for 3.3V Pin: 50mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

PZEM 004T:

These are cheap Energy monitors devices, equipped with a TTL UART communication interface, it can monitor Voltage, Current, Power, and Energy as shown in fig 7.

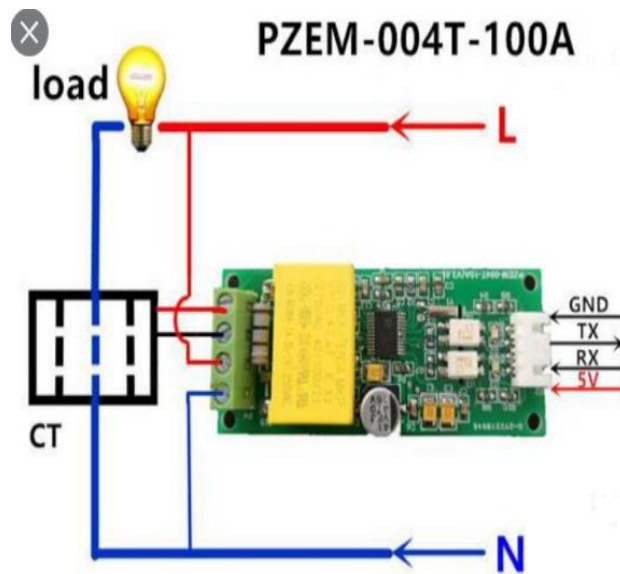


Fig 7: PZEM 004T

Display format:

- 1. Power: Test Range: 0 ~22kW
- 2. Energy: Test Range: 0 ~9999kWh
- 3. Voltage: Test Range: 80 ~260VAC
- 4. Current: Test Range: 0 ~100A

Specifications:

- 1. Working voltage: 80 ~260VAC
- 2. Test voltage: 80 ~260VAC
- 3. Rated power: 100A /22000W
- 4. Working Frequency:45-65Hz
- 5. Measurement accuracy:1.0

RELAY MODULE

This is a LOW Level 5V 2-channel hand-off interface board, and each channel needs a 15-20mA driver current. It very well may be utilized to control different machines and hardware with huge current. It is outfitted with high-current transfers that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled straight forwardly by microcontroller as appeared in Fig8.



Fig 8: Relay Module

4. IMPLEMENTATION

ARDUINO IDE SOFTWARE

The Smart Energy Meter without internet is shown in Fig.9 in which Arduino UNO , LCD , PZEM-004T are connected each other to which AC signal and Current Transformer signals are given to PZEM-004T input part. Thief detection is been identified if there is any tapping from the users power supply, if power exceeds than the regular usage then message will be sent to user.



5. RESULTS

The result for the overview of the home automation using Blynk App is shown in Fig below, in which Automatic Turning ON / OFF of home appliances using Blynk App is controlled by the user .Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in limits from C and C++. It is utilized to compose and transfer programs ventures to Arduino compatible boards, yet furthermore, with the help of outsider centers, other seller development.

BLYNK APPLICATION

Blynk is a platform with iOS and Android applications to control Arduino, Raspberry Pi and the preferences over the Internet. Blynk is utilized as the User interface. Blynk is an hardware agnostic IoT platform with adjustable portable applications, private cloud, gadget the board, analytics and machine learning. Blynk is a hardware-agnostic IoT platform with adjustable versatile applications, private cloud, device management, analytics, and machine learning.



Fig 10: overview of home automation through Blynk app

The result for the overview of the Power Monitor using blynkapp is shown in Fig 11 , in which Voltage, Current, Power and Energy are displayed.

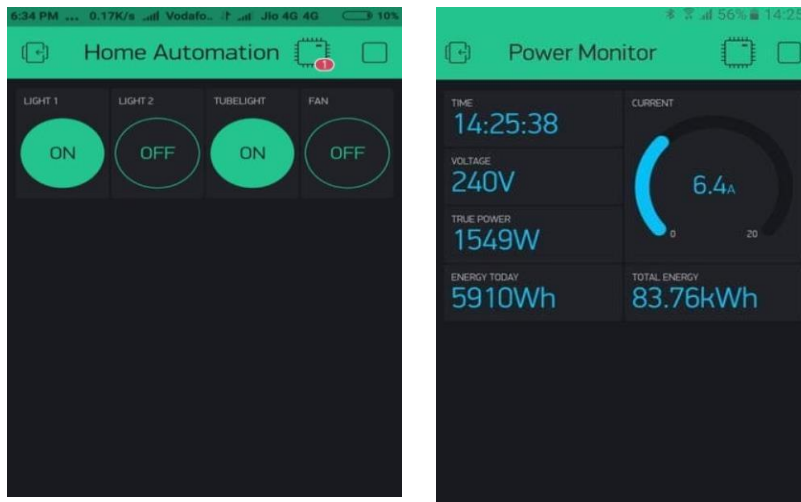


Fig 11: overview of Power Monitor through Blynk Fig 12: overview of displayed Energy Units Using Thing



Fig 13: Display of Energy Units on LCD

The results are displayed in Serial Monitor at baud rate of 115200 as shown in Fig 14 below.

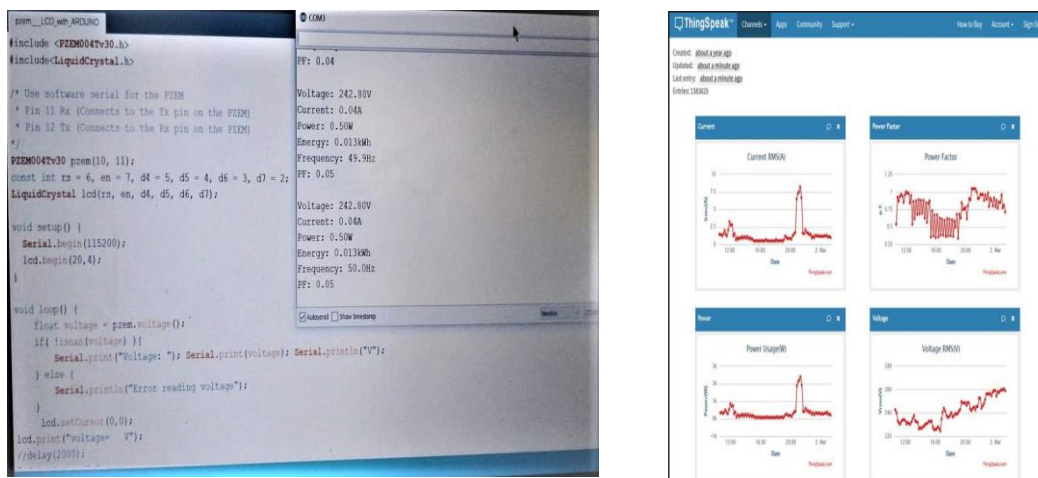


Fig 14: Energy Units display in Serial Monitor Speak.

6. CONCLUSION

Right now, have proposed the WiFi-based Energy meter for web of things (IoT) with the minimal effort execution. The proposed framework can survive and improve the difficulties of Energy effectiveness and reasonability. The parameters of Energy meter can be perused effectively and dependably, for example, load profile, request esteem, and the complete Energy utilization. For IoT usage angle, the WiFi module ESP 8266 works dependably with the end goal that it can send the data to show on the site all through the current server. In rundown, we can accomplish the exceptionally high unwavering quality advanced Energy meter with extremely minimal effort, and it very well may be checking simply like standard Energy meter. Overall Smart Energy Meters are utilized to get precise reading of power units, diminish the energy utilization in households, to identify the burglary power by obscure individual and lessen the power cut issues particularly in rural areas and helps in load balancing by sending message to power grid stations.

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