

## IOT BASED INDUSTRIAL SMART GRID MONITORING USING MQTT PROTOCOL

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**Abstract:** This paper proposes a novel technique to prevent various forms of electricity theft. Electricity theft can be in the form of meter diversity, billing illegitimate and billing inconsistency. It also brings a novel innovation in the form of a smart meter which is an important invention for the above mentioned problem scenario by monitoring the systems in smart grid and collect the information of electricity uses then establish communication with the consumers which can be useful for providers as well as consumer by using message queue telemetry transport protocol. In additionally it provides real time pricing and monitored usage information to the consumers. A simulation framework has been developed that can evaluate values for energy, current and voltage for various appliances which can be sent to the electricity department as well as consumers to prevent the electricity theft, and also it facilitates in bill payment using RFID.

**Keywords:** Smart meter, Electricity theft, Smart Grid, Energy meter, MQTT

### 1. Introduction

Power robbery has risen as a difficult issue in control segments particularly in the creating nations. An immense measure of income is lost because of power robbery. In a few nations this is severe to the point that legislatures are bringing about misfortunes rather than income. At times government needs to give endowments to the power division to keep up a sensible cost of power. The money related misfortune brings about lack of assets for ventures to extend the current influence limit and accordingly governments are neglecting to fulfil the consistently expanding interest of power. Now and again this issue has turned out to be extreme to the point that the influenced control frameworks are close bankrupt. Notwithstanding, in creating and immature nations the act of energy burglary is common to the point that it is frequently kept out of discourse.[1]

Smart Grids (SGs) have been a key empowering influence for Smart Energy, which alludes to power networks that can insightfully coordinate the practices and activities of all partners associated with it, for

instance, generators, clients and those that do both – keeping in mind the end goal to productively convey supportable, monetary and secure power supplies.[2-3] While there are numerous definitions for SGs, one regularly utilized calculated structure is that of the National Institute of Standards and Technology (NIST) which characterizes seven imperative spaces: bulk generation, transmission, distribution, customers, service providers, operations and markets.

Electricity is fundamental necessity of every human being. It is useful for the industrial, domestic, agriculture purpose. Electricity theft is increased at a large scale. Faulty measurements are obtained due to faults in the device or due to electricity theft. Some preventive measure must be taken in order to reduce problem. For solving this purpose, Smart meter system is used[3]. In smart grid system, smart meter plays vital role. Current and voltage sensors are used for measuring the power consumption [4]. Those readings are sent to the consumer as well as Electricity Board by using ZigBee and message Queue Telemetry Transport (MQTT) protocol. MQTT is a network protocol which is used transfer data between publisher and subscriber. It is a publisher and subscriber protocol.

In many regions of the world, smart meters have been installed in homes, industries and other digs[5]. The benefits are easier processing of billing, data processing, mechanized meter reading, discovery of energy losses, rapid discovery of interruption in energy supply, possible real time pricing schemes and well planned use of energy produced[6-7].

### 2. Literature Review

An audit of the prior existing writing on energy meters show that a great deal of progressions have been depicted in work of meters which report and present the power utilization.

[1] This paper introduces a method to control power robbery by using a prepaid vitality metering framework. Framework introduces a keen vitality metering at server and customer unit. By sending a PIN number covered up in a scratch card to the server utilizing SMS, buyers can revive their vitality meter. A

few measures to control altering and meter bypassing have been shown in this paper.

[2] The diverse partner interests and advancements used to fulfil partner interests and metering process are displayed by this paper. Besides the paper features the difficulties and in addition openings emerging because of the expanding ubiquity of cloud situations and appearance of big data.

[3] Non obtrusive current detection is presented in this work which is based on a vitality meter. It has the benefits of resolving power at any end. Vitality utilization attributes for this situation are appeared on an advanced mobile phone. ENC28J60 was utilized to exchange information over the web.

[4] The work plan exhibits that the vitality meter utilizes Arduino micro- controller which is used to increase the power devoured by electrical apparatus. The proposed vitality meter has several applications which include the utilization of power when gadgets are considered and then transferring it to server. It also build up remote control of machines and consequently supports in vitality protection.

[5] In this paper, the vitality administration issue of a brilliant home comprising of renewable energy source (RES), energy storage system (ESS), an arrangement of schedulable home machines, and dynamic power levy is figured. A home energy management system (HEMS) is produced utilizing the blended mixed integer linear programming (MILP) system, meaning to take care of both load booking issue of home machines and the vitality dispatch issue of utility matrix under a solitary streamlining structure continuously.

[6] In this paper, general data about demand response is given and demand response look into on the world and in Turkey is compressed. A re enactment examine is finished to demonstrate the impact of interest reaction application in a private house utilizing load moving. In the recreation think about, electrical machines, which are planned to be utilized at expensive hours, are moved forward so as to control the pinnacle request of the house. Thinking about new savvy apparatuses and internet of things (IOT) applications, the demand response will offer new points of view on electrical vitality age/utilization and on the operation of energy framework.

### 3. Implementation

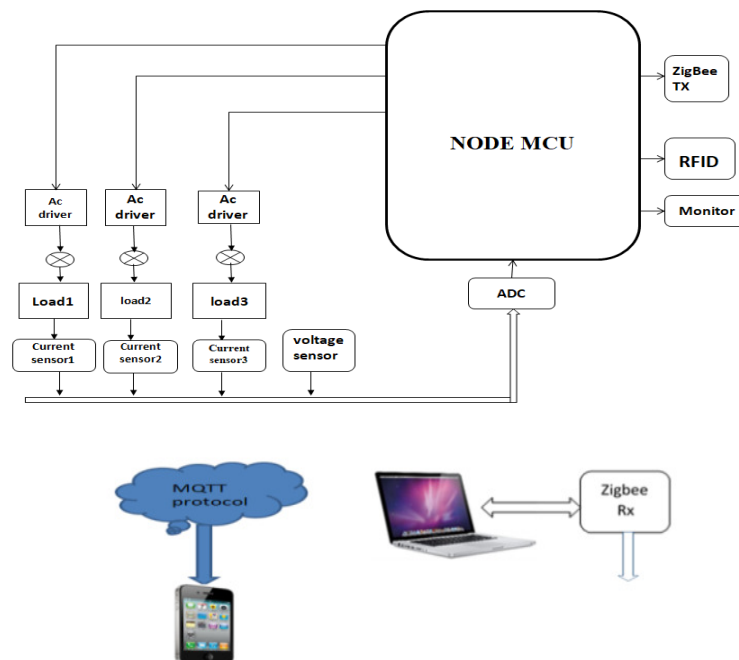


Figure 1. Block diagram of Smart Grid Monitoring

This paper presents the use of WiFi module, instantaneous power can be computed and uploaded on the cloud. Smart grid monitoring system senses the current and voltage values on real time[8-9]. Security is provided by using MQTT protocol. The automatic post

paid and prepaid bill payment is done with the help of RFID tag.

The fundamental piece of the circuit is the current sensor SCT-013-030. The Wi-Fi module ESP 8266 along with Arduino is used for the detection of current

esteems and are conveyed remotely to the server. User display employed via consumers display (mobile phone) as well as monitor

Maximum yield voltage of 1V and current of 30A is detected by using SCT-013030. The microcontroller Arduino Via the Analog to Digital Converter (ADC) input provides the yield voltage. The power is figured in the program and the rms estimation of the signal is estimated. The eradication and fine-tune of rms value of current is illustrated below.

An AC voltage signal, differs between 2.5V to 5V relative to the current sensor. Noise is blocked when samples are cleaned and less frequency is obstructed.  $Vol_{filter}$  is a voltage filter in (1) indicates to the formerly calculated  $Vol_{filter}$  esteem,  $samp$  = present sample esteem while  $prev\_samp$  = previous sample esteem. Here  $x = 0.995$  that is constant. RMS of the  $V_{in}$  signal is procedure utilizing equation 2,

$$Vol_{filter} = x * (Vol_{filtered} + samp - prev\_samp) \quad (1)$$

$$Vol_{rms} = \sqrt{\frac{(Vol_{filter})^2}{Number\ of\ samp}} \quad (2)$$

$$I_{rate} = \frac{A}{B * 5 * No\ of\ samples} \quad (3)$$

The conversion of  $V_{rms}$  into  $I_{rms}$  is given by,

$$I_{rms} = I_{rate} \sqrt{V_{rms}} \quad (4)$$

Current Transformer \_ TURNS speaks to quantity of turns of optional curl of Current Transformer = 1800 and CTBurden resistor = 62. Quantity of tests = 1024, which has 10bit ADC, Current sensor is used for the detection of rms esteem of current i.e registered utilizing (4). At long last the power expended is computed by,

Where  $A = 1800$  i.e quantity of turns of secondary coil and  $B$  is an inner burden resistor = 62. Here No. of tests are 1024, since Arduino is having Analogue to digital converter of 10 bits, i.e. 1024 tests. Current sensor senses the rms value of the current which is registered utilizing equation (4). At last the power expended is obtained by

$$Power\ consumed = 230 * I_{rms} \quad (5)$$

ESP8266 is a minimal effort WiFi module which deals with 802.11b/g/n convention. The ESP module is linked to the server before sending GET request.

Signal conditioning is briefly explained as an implementing in such a way that it gathers the essentials of the later phase for additional processing. It mostly employed for an analogue to digital conversion.

Voltage transformer which is likewise called as a potential transformer. It utilized in electrical vitality control framework for venturing down the voltage of the framework to some secured esteem which is regularly given to low appraising meters and transfers. Monetarily available transfers and meters used for

scope and metering are set up for low voltage, so the potential transformer is ordinarily utilized for venturing down the voltage in appropriation frameworks. In any case, it can be utilized to venture up the voltage too. A voltage transformer idea or potential transformer idea is the same as a hypothesis of fundamental advance down transformer. Between the stage and the ground essential of the voltage transformer is associated. voltage transformer has bring down essential turns than its optional windings, to step down. Sensing stage means the stage which are having sensor, a signal conditioning stage is used for an amplification of the signal, Microprocessor and ADC carry out processing stage. Signal conditioning card is useful for scaling down input signal i.e detected by sensors.

MQTT is a message Queue Telemetry Transport Protocol. It is useful for communication between publisher and subscriber. This lightweight, open, straightforward and simple to-execute convention is reasonable for obliged conditions and relevant in Machine to Machine and IoT settings. MQTT provides optimal bandwidth utilization. It keeps running on TCP as a matter of course however can be keep running on any requested, loss less and bi-directional convention. In this project, we are using MQTT for security purpose. This protocol basically used to secure data with a high speed.

Cloud receives accurate energy esteems via ESP module. MQTT protocol displays energy esteems continuously, it is useful for the evaluation of electricity bill until now. It also incorporates control of gadgets at industries over the web.

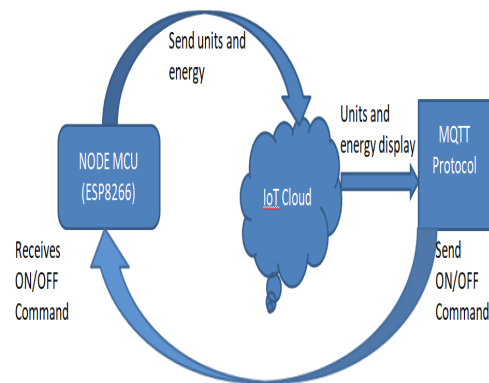


Figure 2. Employment of IoT

User can operate a gadget by selecting ON or OFF separately. ESP module is useful for ON or OFF the device i.e. from ON to OFF. In the wake of detecting the change it impels the hand-off, with the assistance of Arduino to switch ON or turn the gadget, contingent on the present status.

#### 4. Hardware Testing and Results

The analysis of architecture and hardware employment of easily transportable IoT based smart grid monitoring is given[10]. Fig 3 explains the hardware structure of the project along with the PCB. It describes the IoT based industrial smart grid monitoring linked to the supply board for monitoring the energy in a particular industry[11-12]. The power consumption of an industrial smart grid system is displayed by using this system.

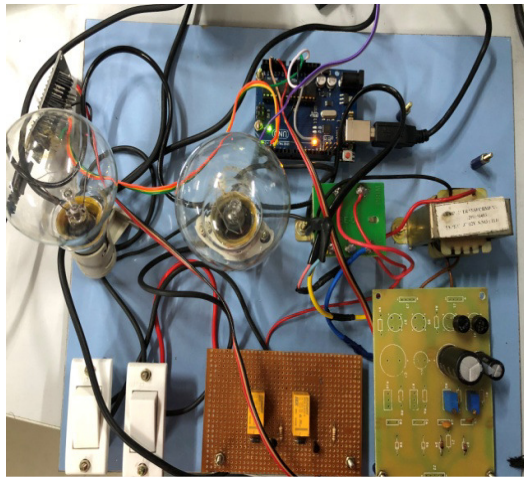
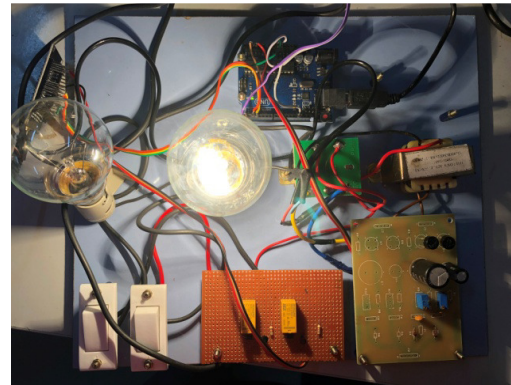


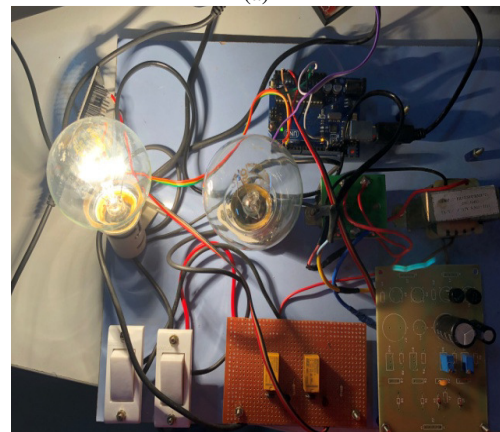
**Figure 3.** Hardware implementation

Fig. 3 shows the employment of the portable device which can show the powers of individual devices. The gadget can be linked to the mobile phone as well as to the desktop display. Display and the mobile phone show the power consumption. This system can be helpful for consumers, so that consumers can find out the power levels of different devices.

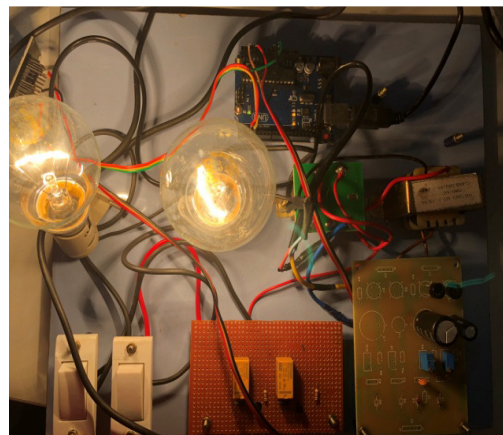
For exploratory point, a bulb1 and bulb 2 will be exchanged ON/OFF with the assistance of this interface. Interface will demonstrate the status of gadget whether it is ON/OFF in light of the past choice of consumer. i.e., If the number 1 is pressed then the bulb1 will be ON., if number 2 is pressed it will be OFF. If number 3 is pressed then bulb 2 will be ON and if number 4 is pressed it will be OFF. On the off chance that, from the everyday control use chart the client finds a disturbing ascent, any heap which devours more power can be remotely controlled. As the energy of a machine expands, the exactness is begun to progress.



(a)



(b)



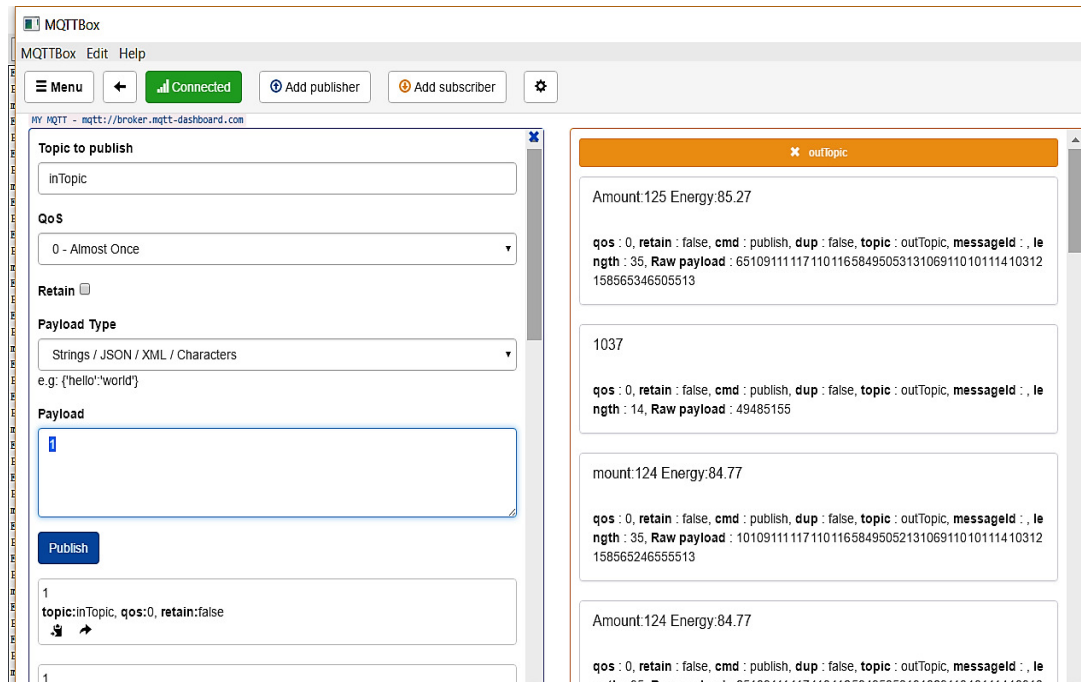
(c)

**Figure 4.** Representation of hardware design (a) Bulb 1 is glowing (b) Bulb 2 is glowing (c) Both the bulbs are glowing

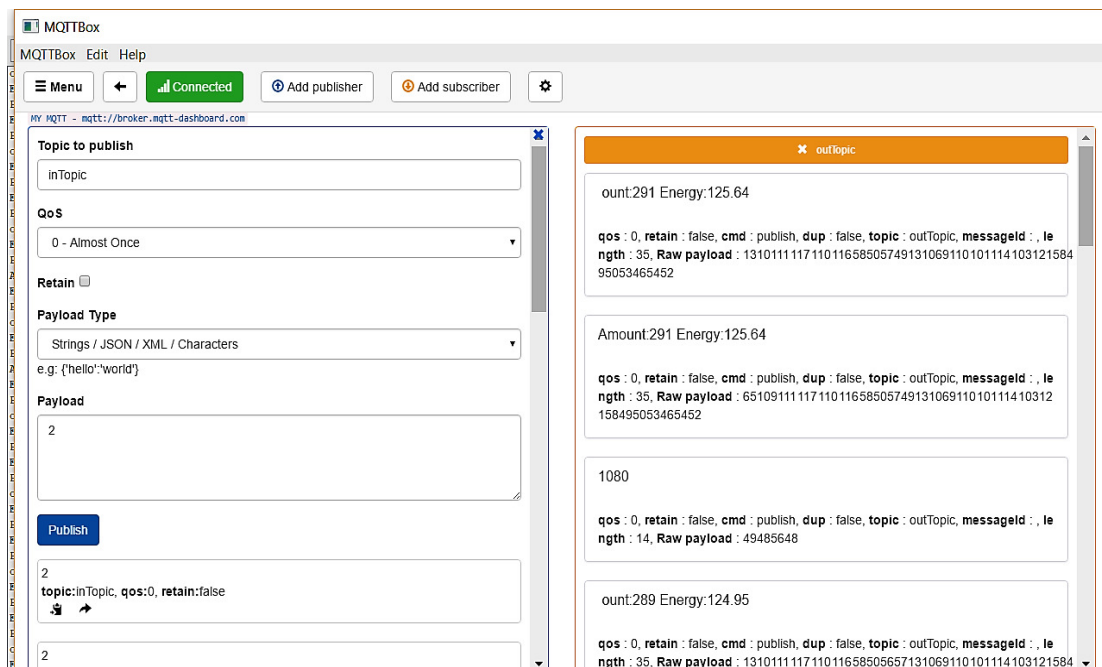
Result shows energy consumption of each bulb in the fig (a),(b),(c) and (d) and the amount has to be paid is

shown in the fig (e), we are using MQTT Protocol which shows the energy consumption and amount to be

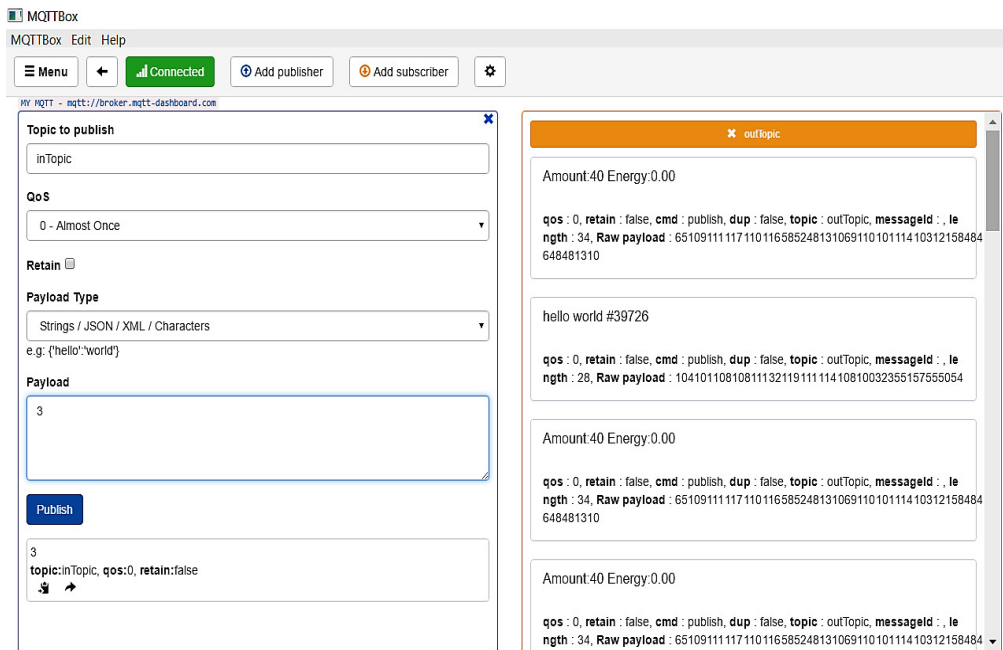
paid. IoT is used for communication between sensors as well as with the consumer.



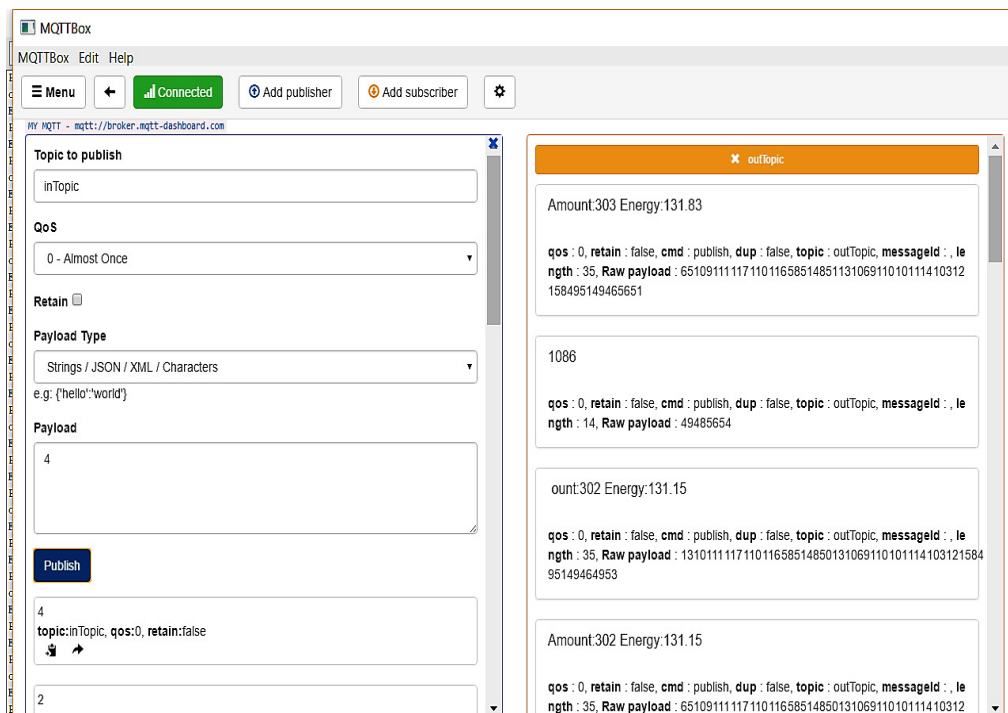
(a)



(b)



(c)



(d)



(e)

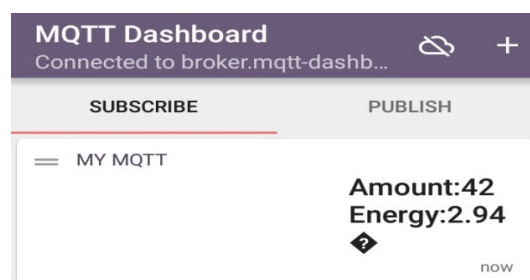


**Figure 5.** Representation of result (a) Bulb 1 is glowing (b) Bulb 1 is off (c) Bulb 2 is glowing (d) Bulb 2 is off (e) Bill payment (f) Output on handset (phone)

## 5. Conclusion

Insignificant power utilization is the primary outline part of any machine. A review into the power devoured by normal appliances gives an attention to the regular clients which promotes in power preservation. This paper introduces the execution of a compact vitality meter which can screen the power utilization at gadget level as well as for industrial purpose. Counting voltage detection and current detection into the equipment and also preparing it to compute power can enhance the precision of this system. Customer can pay the bills by means of using RFID tag. Readings can be securely provided by means of MQTT Protocol.

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