



## Smart Prepaid Energy Meter

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**Abstract:** The main idea of the project is to develop smart energy meter for an automatic metering and billing System. A digital smart prepaid energy meter can reduce the harassment of a consumer and effort of vendors over the traditional physical energy meter reading, billing process and electricity theft can be detected and prevented. The proposed system is implemented using a GSM shield module on microcontroller (Arduino UNO) together with Optocoupler and relay. In this meter energy utilized and the corresponding amount will be displayed on the LCD continuously and communicated to the controlling base station. The main power passes through a relay to the consumer. The disconnection of power supply on demand or due to zero or low balance was implemented using a relay. The detail of power displaced in the energy meter is transferred to the mobile phone of consumer and updated at server of service provider using GSM and it also shows the units consumed by the load and available balance. If the available balance is reduced to certain limit then an alert message will be sent on consumer's mobile phone and after alert message if balance reaches below the set limit for power cut then the system automatically cut the power supply by triggering relay. On successful recharge the power supply will be turned ON by the system. The proposed system replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. This smart energy meter is developed by using low-cost components that are available at the local market.

**Keywords:** Smart Prepaid Energy Meter , Smart Phone, Arduino, GSM, Optocoupler etc

### I. INTRODUCTION

Prepaid Energy Meter using GSM and Arduino  
Prepaid Electricity Energy Meter is a good concept in which you can recharge its balance, like we do in our mobile phones. In this project we are building automated system by using Arduino and GSM module. You can recharge the electricity balance through this system, just by sending a SMS. It can also disconnect the home power supply connection, if there is low or zero balance in the system. And this system will reads the energy meter reading and automatically send some updates to user's mobile phone like low balance alert, cut-off alert, resume alert and recharge alert.  
The smart energy meter utilizes the features of embedded systems i.e. combination of hardware and software in order to implement desired functionality.

Arduino and the application of GSM to introduce 'Smart' concept. With the use of GSM modem the consumer as well as service provider will get the used energy reading with the respective amount. Consumers will even get notification in the form text through GSM when they are about to reach their threshold value, that they have set. The aim of the project is to the queue at the energy meter billing counters and to restrict the usage of energy meter automatically, if the bill is not paid. The project also aims at proposing a minimize system that will reduce the loss of power and revenue due to power thefts and other illegal activities. The work system adopts a totally new concept of "Prepaid Energy Meter". The GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge. This technology holds good for all electricity distribution companies, private communities, IT parks and self-containing housing projects. The implementation of this project will help in better energy management, conservation of

energy and also in doing away with the unnecessary hassles over incorrect billing. The automated billing system will keep track of the real time consumption and will leave little scope for disagreement on consumption and billing. It is observed that one of the faulty subsystems contributing to the huge revenue loss in Nigerian Power Sector is the metering and billing system. Errors get introduced at every stage of energy billing, like: errors with electro-mechanical meters, human errors while noting down the meter reading; and error while processing the paid bills and the due bills. The remedy for this drawback is a prepaid energy billing. There are clear results from many countries, where prepaid system has reduced the revenue loss by a large amount. A GSM-based Energy Recharge Interface which contains a prepaid card equivalent to a mobile SIM card. The prepaid card communicates with the power utility using GSM communication network. Once the prepaid card is out of balance, the consumer load is disconnected from the utility supply by the latching Relay (contactor). The power utility can recharge the prepaid card remotely through GSM/SMS mode base on customer requests. The results obtained shows good system performance. A prior billing is bound to do away with the problems of unpaid bills and human error in meter readings, thereby ensuring justified revenue for the utility.

## II. LITERATURE REVIEW

**Sagar Rathee** (June 2020) introduced a smart prepaid energy metering solution for big government or private institutes where there are many recreational centres like sports complex and hence considerable amount of energy wastage. In this system, an energy meter is installed in every sports complex and common area; and a server is maintained at the institute level. To facilitate bi-directional communication between the server and consumer's meter, data is transmitted over the power line using Power Line modem or adapters. Energy consumption is calculated by using the "meter constant", and this data is sent by meters to the server. Frequency of data sent by the meter is not fixed but is dependent on Real time load. Each of the meters will also send information regarding its health. Collected data will be compared with available balance; electricity will not be supplied in case of not available balance. The users can control the power supply remotely and hence stopping the unauthorised use of electricity. This system also helps in managing electricity during a power outage and in fault detection.

**N Mahfuz** (July 2020) presented a very effective solution to reduce the harassment of a consumer and effort of vendors over the traditional physical energy meter reading and billing process with a smart energy meter and digital billing system.

This energy meter can measure the real-time consumed energy and store this data into an SD card. For determining the consumed energy different electrical parameters such as AC voltage, the current, phase angle is measured against real-time. It can be implemented in both the prepaid and post-paid billing system. The proposed energy meter has a 20\*4 LCD for understating the consumed energy or remaining energy to consumers. A GSM modem is integrated with the system that allows the vendor to inquire about consumed energy and making digital billing without errors. The main power passes through a relay to the consumer. The vendor can cut off or on the consumer's power supply by triggering relay via SMS. By implementing this smart energy meter, the vendor can ensure the proper use of energy. That will be a huge improvement on the national power grid. This smart energy meter is developed by using low-cost components that are available at the local market.

**HK Patel** (2019) introduced a system that removes human intervention in meter readings and bill generation thereby reducing the error that usually causes chaos and energy related corruption. The proposed system is implemented using a GSM shield module on

microcontroller (Arduino®) together with LDR sensor and relay. Existing metering system can be minutely modified to implement the proposed meter. The proposed scheme is to connect an LDR sensor with the blinking LED and send the data to microcontroller via GSM shield. RTC provides delay and acts an interrupt. The system includes a provision of sending an SMS to user for update on energy consumption along with final bill generation along with the freedom of load re-configuration via SMS. The disconnection of power supply on demand or due to pending dues was implemented using a relay. Hardware implementation results suggest that the accuracy of the proposed system is slightly greater than that of existing smart meters. The cost of system has been estimated to be less than the available smart meters, offering the same functionality. Bilateral communication between user and system sets it apart from the commonly available smart meters

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**EI Abbas** (2018) introduced a modified management system for smart electrical energy meter. The proposed smart meter has feature to inform the consumer about energy consumption, this feature serves energy consumption reduction by self-awareness of real consumption. The other important feature is to eliminating the difficulties by direct contact by employee and consumer to getting the reading of the conventional meter and also reduction of error in bill. The proposal system consists of two parts: client's side part (the prepaid meters in consumer houses) and server side (electrical sub-station). The client part consists of an RFID reader, credit cards, GSM network, Arduino microcontroller and electronic meter. The system operates with high accuracy which could tell the user the amount of energy consumed at any moment and these results the user will be urged to rationalize energy consumption.

**P Loganthurai** (March 2017) The main idea of the project is to modernize our billing system using GSM

The GSM is a technique works on the principle of TDMA – time division multiple access and operates at the frequency of 900MHZ. The details of power displaced in the energy meter is transferred to the mobile using GSM and it also shows the units consumed by the load. If the number of units consumed by the total load exceeds certain limit means it will gives a warning based on tariff and also we are doing to turn ON and turn OFF the load by setting password to each load using GSM technique. Thus with the help of this project we can reduce the electricity bills.

**Visalatchi S** (April 2017) followed a new procedure which is based on MICROCONTROLLER Atmega328P to detect and control the energy meter from power theft and solve it by remotely disconnect and reconnecting the service (line) of a particular consumer. An SMS will be sent automatically to the utility central server through GSM module whenever unauthorized activities detected and a separate message will send back to the microcontroller in order to disconnect the unauthorized supply. A unique method is implemented by interspersed the GSM feature into smart meters with Solid state relay to deal with the non-technical losses, billing difficulties, and voltage fluctuation complication.

**Sneha Chaudhary** (May 2017) presented a smart energy meter for an automatic and superior metering and billing system. The integration of

the Arduino and GSM Short Message Service (SMS) provide the meter reading system with some automatic functions that are predefined. The proposed energy meter system can incorporate with embedded controller and GSM modem to transmit the data like consumed energy in kWh, generated bill, security services (line Cut/On) over GSM mobile network such as data can be then fed and integrated into existing energy management systems located at power companies or organizations to provide the services among the customers without man-power.

**V Preethi** (2016) presented a smart energy meter for an automatic metering and billing system. In this meter energy utilized and the corresponding amount will be displayed on the LCD continuously and communicated to the controlling base station. The feedback from the user helps in identifying the usage between authorized and unauthorized users which helps in controlling the power theft. Communication between user/household and substation is done using Zigbee. GSM network is used for sending SMS to the local authorities regarding the theft cases. This meter can work as either prepaid or post-paid meter. The proposed system replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. Also they can monitor the meter readings regularly without the person visiting each house.

### III. METHODOLOGY

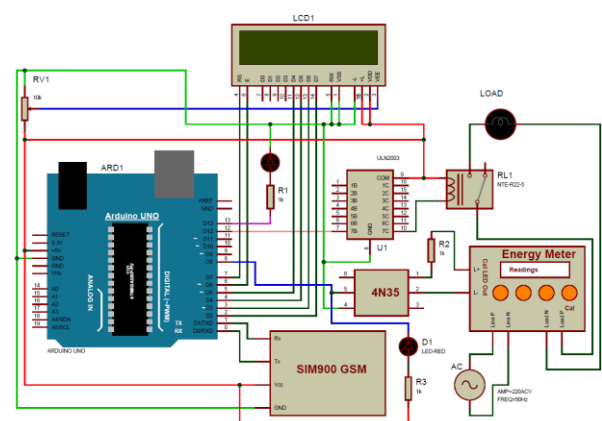
In The Proposed a system in which a smart energy meter is installed in every consumer unit and a server is maintained at the service provider side. Both the meter and the server are equipped with GSM module which facilitates bidirectional communication between the two ends using the existing GSM infrastructure. Consumers can easily recharge their energy meter by sending a PIN number hidden in a scratch card to the server using SMS. This paper presents some measures to control meter bypassing and tampering. The bidirectional GSM communication using SMS ensures the effectiveness of these measures. Pilferage of electricity can be substantially reduced by incorporating the proposed measures along with the prepaid metering scheme. modelling and development of different components of the proposed smart home automation are presented in detail.

1. **Arduino uno:** The Arduino Uno is an open-source microcontroller board based on the Microchip atmega328p microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. [4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.
2. **Relay Module** Relay operation is signalled by one blue LED, this is for all four relay modules, it could be better if each relay module had its own signalling LED. The output screw terminals are marked 1-2-3, it would be better if their manufacturer marked NC-COM-NO, this marking better describes the condition of the relay. The relay can also switch other than the supply voltage, for example 110V or 240V (be careful, the power supply from the source must always be 12V)
3. **GSM SIM 900a:** The SIM900A is a readily available GSM/GPRS module, used in many mobile phones and PDA. The module can also be used for developing IOT (Internet of Things) and Embedded Applications. SIM900A is a dual-band

GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz. SIM900A features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS3 and CS-4.

4. **LCD DISPLAY 16X2:** 16x2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8x1, 8x2, 10x2, 16x1, etc. but the most used one is the 16x2 LCD. So, it will have (16x2=32) 32 characters in total and each character will be made of 5x8 Pixel Dots. Now, we know that each character has (5x8=40) 40 Pixels and for 32 Characters we will have (32x40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen. If you are an advanced programmer and would like to create your own library for interfacing your Microcontroller with this LCD module then you have to understand the HD44780 IC working and commands which can be found its datasheet.
5. **Analog energy meter :** An analog power meter is a device that features a printed display to indicate any electrical parameter. An example could be the energy consumed by a typical business, or electrical device. Also called an electromechanical meter, these offer a simple to read display.
6. **Optocoupler:** Optocouplers can either be used on their own as a switching device, or used with other electronic devices to provide isolation between low and high voltage circuits. You'll typically find these devices being used for: Microprocessor input/output switching. DC and AC power control.

### IV. CIRCUIT DIAGRAM:



## V. WORKING:

When we power up the system then it read previous values of rupees stored in EEPROM and restores the min to the variables then checks the available balance with the predefined value and take action according to them, like if available balance is greater than 15 rupees then Arduino turns On the electricity of home or office by using relay. And if balance is less than 15 rupees then Arduino sends a SMS to user phone regarding low balance alert and requesting to recharge soon. And if balance is less than 5 rupees then Arduino turns off the electricity connection of home and sends a SMS to user's phone for 'Light Cut' alert and requesting to recharge soon. GSM module has been used to send and receive messages, you can check about GSM module and AT commands.

### Advantages:

- Eliminating manual meter reading
- Monitoring the electric system more quickly
- No incorrect bills
- No account queries
- Up front payment of electricity
- No payment of bills
- Load control

( Consumers can access real time information on energy consumption in an in-home display unit, thus allowing consumers to understand their energy use that can translate into energy and capital savings for the consumers. )

### Future Scope:

Smart metering is the quickly becoming the new norm in the power and utility industry.

Addition of various sensors for more precise and safe working of the system.

**Conclusion:** The system design is utilized to simplify the operation of the electric service billing payment. This design is proposed to solve the problems which are resulted from the traditional billing. Its simple to recharge the meter balance and to control and monitor the home appliance remotely by the consumer mobile using SMS.

The meter give a notification to the consumer about any new activity which may occur in it , such as : the balance recharging, the balance turn off, unit price value updating, etc. As any IoT application, this design will simplify the human life.

## VII. REFERENCES AND BIBLIOGRAPHY

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