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The Smart Energy Meter

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Abstract: ***Energy conservation is the effort made to reduce the consumption of energy by using less of an energy service. This can be achieved either by using energy more efficiently or by reducing the amount of service used. Energy conservation is a part of the concept of Eco-sufficiency. Energy consumption monitoring at domestic or industrial locations is required to understand the trends over a period of time.***
The data acquired during monitoring is useful for taking necessary steps to save the energy. In this project we have developed a Smart Energy Meter system using GSM technology which also has a additional component added which is capacitor which can send you updates about the energy consumption at a particular interval of time and the capacitor is added as the output of the energy meter so as to lower the Electricity Bill.
You will be using an Arduino development board as a processing unit.As part of this course you will learn about GSM technology, electrical loads and their measurement, Arduino development boards, Arduino environment and will implement Arduino programming for building your Smart Energy Meter system.This smart energy meter can send the amount energy consumed in a fixed period of time as a sms at regular intervals to the mobile phone. This data can be then be plotted as a graph to understand the energy consumption over a period of time.
Keywords: Energy Meter, Arduino UNO Board, GSM Module, Capacitor.

I. INTRODUCTION

Energy conservation is the effort made to reduce the consumption of energy by using less of an energy service. This can be achieved either by using energy more efficiently (using less energy for a constant service) or by reducing the amount of service used (for example, by driving less).
Energy conservation is a part of the concept of Eco-sufficiency. Save energy, Save the environment - Although it may not be obvious, there's a direct connection between your energy use and the environment.
When you consume less power, you reduce the amount of toxic fumes released by power plants, conserve the earth's natural resources and protect ecosystems from destruction. By taking steps to reduce your energy intake, you'll contribute to a healthier and happier world. Protect the air and prevent climate change - Perhaps the most notable way that reducing energy helps the environment is by decreasing power plant emissions.
To generate electricity, most power plants burn coal, crude oil or other fossil fuels. Although this method of creating energy is relatively inexpensive, our planet pays the price – carbon dioxide, sulfur dioxide and nitrogen oxides are just a few of the by products that come from traditional methods of power generation. Carbon dioxide, which accounts for the majority of all airborne pollution, is a greenhouse gas.
When carbon dioxide is released into the air, it absorbs the sun's warmth and keeps heat in our atmosphere. This "greenhouse effect" is a natural phenomenon, and it's necessary for survival on earth. However, as power plants burn more fuel to create more energy, the extra carbon waste traps too much heat.
This can have a detrimental impact on our land and our lives. Effects of greenhouse gas emissions include: Rising temperatures, heat waves and drought **,** Higher sea levels**,** Abnormal weather patterns **,** Increased intensity of natural disasters**,** Smog and acid rain .Cutting back on energy consumption reduces the amount of electricity that power plants have to make, subsequently reducing the amount of fossil fuels that are burned each day.
To overcome this, we will create an IOT based Smart Energy Meter System. We have developed a Smart Energy Meter system using GSM technology which can send you updates about the energy consumption at a particular interval of time and the capacitor is added as the output of the energy meter so as to lower the Electricity Bill. You will be using an Arduino development board as a processing unit.

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II. BLOCK DIAGRAM

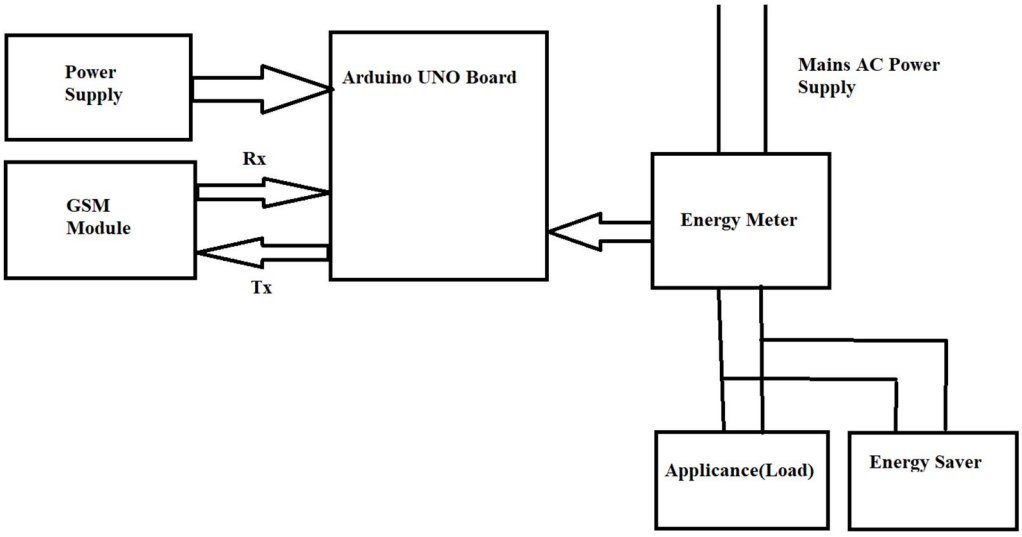
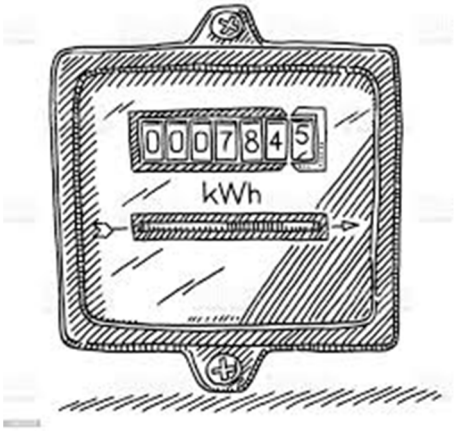


Diagram: Architecture of the Model

III.COMPONENTS OF MODEL

The Smart Energy Meter consist of various components like Energy Meter, Arduino UNO Board, GSM Module, Capacitor, Mobile Phone, Load.

A. Energy Meter



An electricity meter, electric meter, electrical meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. Electric utilities use electric meters installed at customers' premises for billing and monitoring purposes.They are typically calibrated in billing units, the most common one being the kilowatt hour (*kWh*). They are usually read once each billing period. Energy meter or watt-hour meter is an electrical instrument that measures the amount of electrical energy used by the consumers. Utilities is one of the electrical departments, which install these instruments at every place like homes, industries, organizations, commercial buildings to charge for the electricity consumption by loads such as lights, fans, refrigerators and other home appliances.Energy meter measures the rapid voltage and currents, calculate their product and give instantaneous power. This power is integrated over a time interval, which gives the energy utilized over that time period.

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B. Arduino Uno Board

Arduino board is the heart of our system. Entire functioning of system depends on this board. Arduino reacts to the 5v supply given by opto-coupler and keeps on counting the supply and then calculates the power consumed and also the cost. This data, it continuously stores on webpage, so that users can visit any time and check their consumption. It even reacts accordingly as per programed, to the situations like message sending during threshold value etc. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits.The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the "Arduino language". In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool (arduino-cli) developed in Go.

C. GSM Module (SIM800)

GSM stands for Global System for Mobile communication. It is widely used mobile communication modem system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHZ, 900MHZ, 1800MHZ, 1900MHZ frequency bands. It has ability to carry 64kbps to 120Mbps of data rates.In our system GSM is used to send the notification of threshold reaching to consumer and for sending message of total consumption of unit with cost to the service provider and consumer.

The SMS gateway or SMS-G is used jointly to explain two SMS-Gateways in the GSM standards. These gateways control messages which are directed in dissimilar ways.The Short Message Service Gateway Mobile Switching Centre (SMS-GMSC) is used for short messages which are being transmitted to an ME. The Short Message Service Inter-Working Mobile Switching Centre (SMS-IWMSC) is used for short messages created through a mobile network. The main role of SMS-GMSC is related to GMSC, but the SMS-IWMSC offers a permanent access end to the SMS Centre.These units were the major ones that are used in the network of GSM technology. They were normally co-located, however frequently the overall middle network was transmitted around the country wherever the network was situated. In case of malfunction, it will give some flexibility.

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D. Load

An electrical load is an electrical component or portion of a circuit that consumes (active) electric power. This is opposed to a power source, such as a battery or generator, which produces power. In electric power circuits examples of loads are appliances and lights. The term may also refer to the power consumed by a circuit.

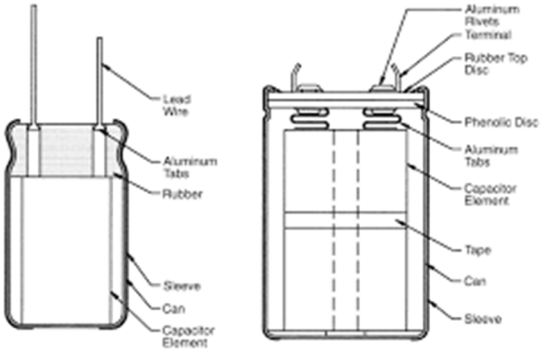
The term is used more broadly in electronics for a device connected to a signal source, whether or not it consumes power.[2] If an electric circuit has an output port, a pair of terminals that produces an electrical signal, the circuit connected to this terminal (or its input impedance) is the *load*. For example, if a CD player is connected to an amplifier, the CD player is the source and the amplifier is the load.[2]

Load affects the performance of circuits with respect to output voltages or currents, such as in sensors, voltage sources, and amplifiers. Mains power outlets provide an easy example: they supply power at constant voltage, with electrical appliances connected to the power circuit collectively making up the load. When a high-power appliance switches on, it dramatically reduces the load impedance.

E. Device

A mobile device is a computer small enough to hold and operate in the hand. Typically, any handheld computer device will have an LCD or OLED flatscreen interface, providing a touchscreen interface with digital buttons and keyboard or physical buttons along with a physical keyboard. Here the SMS is sent from the GSM Module which sends the data of the power consumed by the energy meter to the mobile device

F. Capacitor



A capacitor is a two-terminal, electrical component. Along with resistors and inductors, they are one of the most fundamental **passive** components we use. You would have to look very hard to find a circuit which *didn't* have a capacitor in it. A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals.
The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser or condensator.[1] This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones. The simplest way to improve power factor is to add PF correction capacitors to the electrical system. PF correction capacitors act as reactive current generators. They help offset the non-working power used by inductive loads, thereby improving the power factor.

IV. WORKING OF MODEL

An electricity meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. The readings of Energy Meter will directly be given to the Arduino UNO Development Board ATMEGA328P.A Smart Energy Meter system using GSM technology which can send you updates about the energy consumption at a particular interval of time and the capacitor is added as the output of the energy meter so as to lower the bill. You will be using an Arduino development board as a processing unit. As part of this course you will learn about GSM technology, electrical loads and their measurement, Arduino development boards, Arduino environment and will implement Arduino programming for building your Smart Energy Meter system.This smart energy meter can send the amount energy consumed in a fixed period of time as a sms(Short Message Service) at regular intervals to the mobile phone. This data can be then be plotted as a graph to understand the energy consumption over a period of time.

V. ENERGY

Let's first discuss about the what energy is ? And why we need to save energy? What is harm to the environmen that energy generation causes ? And further we will discuss about the factors that help in the reducing the electricity bills?

A. What is Meant by Energy?

Energy is essential to life and all living organisms. The sun, directly or indirectly, is the source of all the energy available on Earth. In Physics, energy is a quantitative property that must be transferred to an object in order for it to perform work. Hence, we can define energy as the strength to do any kind of physical activity. Energy is conserved quantity and the law of conservation of energy states that energy can neither be created nor destroyed but can only be converted from one form to another. The SI unit of energy is Joule.

B. Why we Need to Save Energy?

There are a number of reasons why you should consider cutting back on energy consumption. First of all, reducing energy use limits the number of carbon emissions in the environment. Carbon emissions play a significant role in climate change, which is thought to be the cause of powerful natural disasters in recent years. With billions of harmful emissions in the atmosphere, cutting back is always a good thing.In turn, conserving energy produces a higher quality of life. Reduced emissions result in cleaner air quality. In addition, it helps create a healthier planet, or at least helps sustain the resources we already have. Being conservative with energy can ensure that lakes, trees and animals are around for future generations.

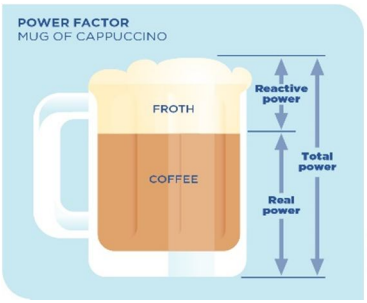
C. Impact on the Environment Caused by Energy Generation.

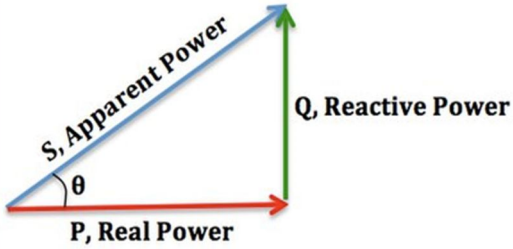
All forms of electricity generation have an environmental impact on our air, water and land, but it varies. Producing and using electricity more efficiently reduces both the amount of fuel needed to generate electricity and the amount of greenhouse gases and other air pollution emitted as a result. Electricity from renewable resources such as solar, geothermal, and wind generally does not contribute to climate change or local air pollution since no fuels are combusted. **Carbon dioxide** (**CO_2**) makes up the vast majority of greenhouse gas emissions from the sector, but smaller amounts of methane (**CH_4**) and nitrous oxide (N_2O) are also emitted. These gases are released during the combustion of fossil fuels, such as coal, oil, and **natural gas**, to produce electricity. An **increase** in the amount of **carbon dioxide** creates an overabundance of greenhouse gases that trap additional heat. This trapped heat leads to melting ice caps and rising ocean levels, which **cause** flooding. Increases in carbon dioxide in the atmosphere affect marine animals in several ways.

D. Factors that help in Reducing the Electricity bill?

Reduce electricity bills by eliminating power factor surcharges. Enhance equipment operation by improving voltage. Improve energy efficiency of your electrical system by reducing line losses. Eliminate or reduce transformer maintenance or upgrades.

1) *Power Factor:* Power factor (PF) is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). Apparent power, also known as demand, is the measure of the amount of power used to run machinery and equipment during a certain period. It is found by multiplying (kVA = V x A).





Lets take an example of a Mug of Cappuccino Looking at our **beer** mug analogy above, **power factor** would be the ratio of Cappuccino (KW) to Cappuccino plus foam (KVA). KVAR), the higher your ratio of KW (Cappuccino) to KVA (Cappuccino plus foam). In fact, as your foam (or KVAR) approaches zero, your **power factor** approaches 1.0.

2) *Improving the Power Factor:* One can use the Capacitors. Improving the PF can maximize current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. The simplest way to improve power factor is to add PF correction capacitors to the electrical system. PF correction capacitors act as reactive current generators.

VI. CONCLUSION

Arduino and GSM based Smart Energy Meter for advanced metering and billing system is built which is able to read and send data via wireless protocol using GSM technology through GSM modem, capable of manage the meter as well as the line connection with an additional component used capacitor which helps in improving the power factor. However this project needs more modification for more reliable and higher degree of satisfaction and safety. For GSM module the network coverage of the SIM used is one of the important facts. The network strength should strong so that the GSM module can work well. One of the most important facts for this project is high cost of the component so that the overall cost of this project is high. Due to educational purpose and for research the equipment is provided with all pin connection, features and all possible events.

VII. ACKNOWLEDGEMENT

It gives us great pleasure in presenting the paper on “Smart Energy Metering using GSM and IOT”. We would like to take this opportunity to thank our internal guide of Information Technology Department,Pimpri Chinchwad Polytechnic College for giving us all the help and guidance we needed. We are really grateful to them for their kind support. Their valuable suggestions were very helpful. We are also grateful to Prof.Vidya Byakod, Prof.Sonali Mortale, Prof.Madhavi Mali project coordinators, Information Technology department for their indispensable support and suggestions.

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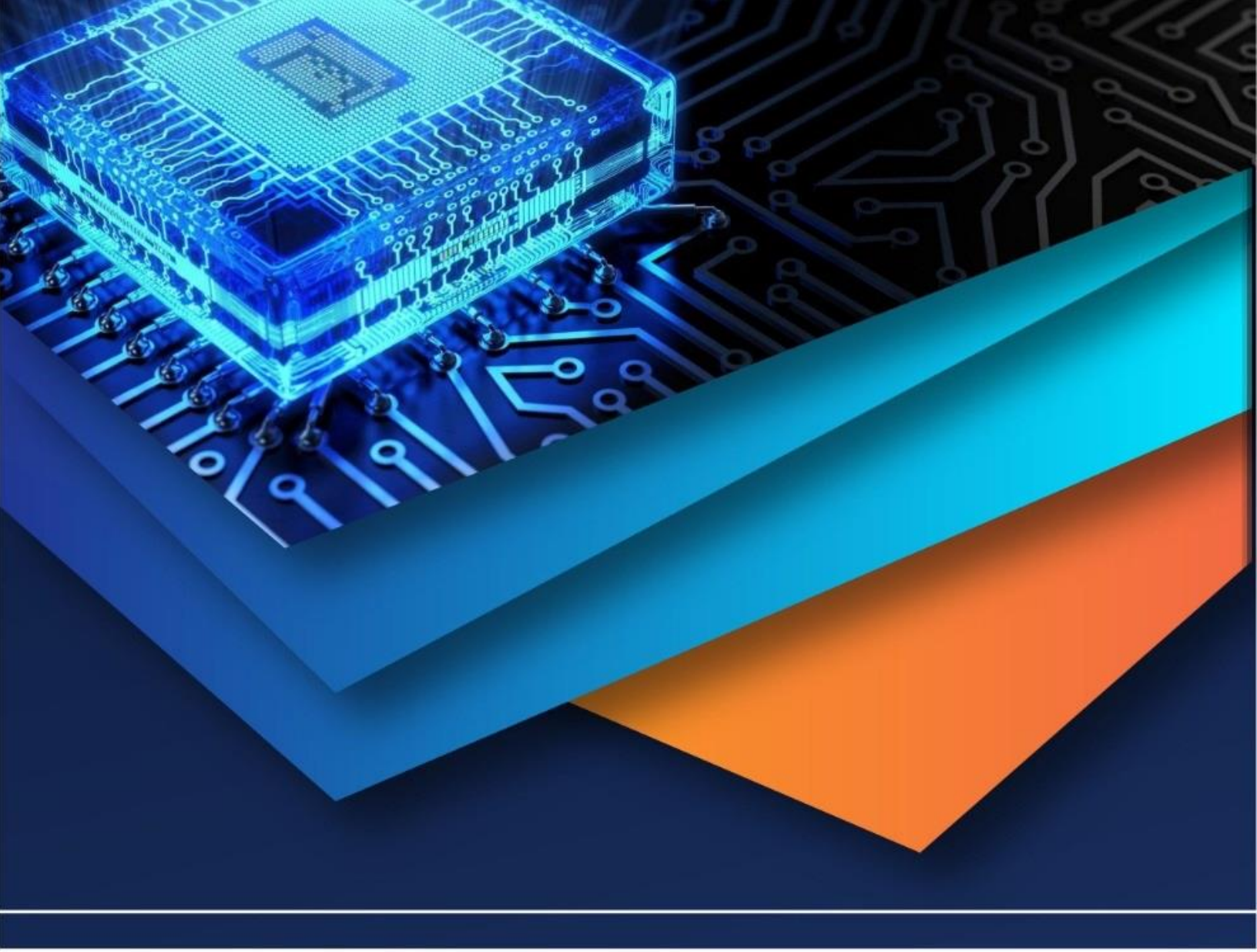

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