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Smart Grid using Node MCU

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Abstract: *With increase in population and infrastructure, need for energy production is gradually increasing and to full fill the demanding needs of consumers is in organization hands. This brings the issue of energy production and energy distribution for the organization.*
Existing meters are not so consumer friendly and always need a periodic checking from utility to inform about their monthly tariff, which requires more man power and is a time consuming process. Also the organization is not able to maintain proper record of consumer data.
This project aims to reduce this burden and it makes a real time observation of energy consumption for the consumer as well as the organization. The consumer as well as the organization is able to monitor the real time usage of energy and receive notification to their mobile or on organization website. Also, it notifies the consumer about the peak hours and the grid is able to monitor their geographical area.
This project involves Node MCU as main controller and for internet communication and sending real time data over internet, current and voltage sensors.
Keywords: *Node MCU, ACS712, Relay.*

I. Introduction

WHAT IS SMART GRID?
Smart grid is an electrical grid which incorporates a spread of operations and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficient resources. Through technology, we are now able to communicate between the utility and the customer and sensing along transmissions.

Smart grid will enable us to:
1. Efficient transmission of energy.
2. Quick restoration of energy after power disturbance.
3. Reduced operations and management costs for utilities, lower power costs for consumers.
4. Increased integration of large scale renewable energy source.
5. Maintain and improve the existing services.

Bringing more transparency to the consumer and enable monitoring real time consumption of the energy. Handle the power outrages with the help of sensors, containing them before they become large scale blackouts. Bring more awareness to consumers about connection between electricity use and environment.

Smart grid technology also implies a fundamental re-engineering of energy services although typical usage is based on the technical infrastructure.

UNDERSTANDING AC CURRENT/POWER

Alternating current is an electric current which periodically reverses direction, in contrast to Direct current(DC) which flows in one direction only. AC is the form in which electric power is delivered to business and residences, and is the form of energy that consumers use at their house wall socket.

Power in an electric circuit is rate of flow of energy passed given point of circuit. In alternating current circuits, energy storage elements such as indicators and capacitors may result in periodic intervals of direction of energy flows.

II. Literature Survey

Latest contributions now allow the consumer to utilize the energy efficiently, with the help of technology now the consumer is able to determine the real time consumption and manage accordingly. Renewable energy plays major role in cutting the peak price hours and using the energy more conservatively. Now the grid is also able to monitor in the supplying geographical area, and determine if there is any disconnection or power break in the connection. This also helps in decreasing the man power that we used earlier for periodic checking and also conserving the energy for the future purpose.

Now the consumers are able to pay for the bills from their smartphones itself. Monitor the usage and allow to control the power to minimize the costs. IoT enables the organization to monitor the area for any energy theft, overloading or under-loading, power break etc. in the real time so as to resolve the issue as soon as possible to allow uninterrupted usage of energy. And through the use of renewable resources, distribution of energy becomes more efficient and supplying energy in coastal or rural areas becomes more of an easy task. Different kind of smart grid systems that are being proposed:

1. SMART ENERGY METER WITH ADVANCED FEATURES AND BILLING SYSTEM

Paper presented by University of Engineering and Technology, Taxila , presents designing, implementation of cost effective Energy Meter having demand side load management with flexible tariff plan. Smart Energy Meter with enabling feature of Automatic Meter Reading network, tampering detection, communication of billing information with consumer and utility through GSM. Using load management customer can enter daily cost reduction process. Consumer load limit is flexibly reduced during peak hours and by increasing this limit grid automatically cut off the load.

2. SMART ENERGY METER

The integration of micro-controller and GSM short message service provides the meter reading system with automatic functions that are predefined. The GSM module requires SIM card just like mobile phones to activate communication with the network. DC components are used to control AC loads. To isolate these components from each other, relays with network of resistors and diodes are used. Users can recharge and control loads remotely. Utility companies also have remote access to system such as fault diagnosis and communicating with clients. Other advantages include that system provides domestic power consumption accurately, safely and with relatively fast update rate.

3. SMART COMPONENTS FOR SMART ENERGY METER

The Smart Devices can facilitate the reductions or shifts in overall energy consumption by averaging out the energy that is being consumed on regular and timely basis. The usage of power can be recorded on database over the internet where the customer can access his account using credentials given to him. There are signals that act as indications such that extra energy other than the energy that is averaged out can be utilized at some other place. The costs are primarily high due to complex set of communications and communication-related features such as encryption, load profile-storage, multiple two-way secure communications, interfaces to communication and operating devices.

4. ANDROID BASED SMART ENERGY METER

The main objective of this paper is to form intelligence of normal energy meter system. In existing energy meter only the quantity of used power can be perceived, but we cannot monitor voltage, current, active power, reactive power. The process is started with the main 220V AC line that is delivered from the power line. Line voltage and current are measured by voltage and current sensor. Combination of hardware and software for the system are verified and fully tested. Although there are a few limitations and difficulties encountered during development of project, the system works as expected. By developing a sensible energy meter system and by using upcoming techniques one are often benefited in several cases.

5. IP BASED SMART ENERGY METERING ENERGY SAVING

Smart measurement and control systems contribute to energy savings and are capable of instantly receiving information about their environments. In this study, an electronic measurement and system was developed by installing an coaxial cable under WLAN with remote power access which has the power to live and control electricity consumption. The system uses sensors capable of receiving information on devices connected to the system, and has the energy saving capability to stop sleep mode power consumption. The development of the electronic measurement and system and its software are described and therefore the experimental results are presented. In the study, results are given of tests administered for various establishments by using the system algorithm with the Internet-based Group Socket System.

Comparing proposed models

Features	Smart Energy Meter with Advanced Features and Billing System	Smart Energy Meter	Smart Components for Smart Energy Meter	Android Based Smart Energy Meter	IP Based Smart Energy Metering with Energy Saving	**Smart Grid using Arduino and Node MCU**
Billing	Y	Y	Y	Y	Y	Y
Theft Alert	Y		Y		Y	Y
Power outbreak Alert						Y
Controlling appliances with mobile app.					Y	Y
Peak Hour notification	Y			Y		Y
Real time power usage analysis					Y	Y

III. Equipment's Used

We have used Node MCU for communicating over internet and receiving input from the consumer/organization, ACS712 current sensor for analysing current consumption, Voltage sensor for measuring voltage, Relay is used as switch for connecting the load and controlling the relay with help of the Node MCU.

1. Node MCU

Node MCU or Node MCU ESP8266 is an open source LUA based firmware developed for ESP8266 wifi chip. The hardware design is open for edit/modify/build. Node MCU board consist of ESP8266 wifi enabled chip. Its a low cost wifi chip developed by Espressif Systems with TCP/IP protocol.

In the project, Node MCU will be used for sending energy related information like the energy consumption and the appliances connected to the consumer/organization and also taking inputs from the end-user. Several IoT platforms allow to integrate with Node MCU and allow to communicate with the board such as Blynk, ThingSpeak. Connecting the board with the relay will allow us to control it and turn on/off the appliances accordingly.

2. ACS712 Current Sensor

ACS712 is a cheap, low accuracy, harmonic source cannot measure more than 10A load current. Current sensing is done in two ways – Direct sensing and Indirect sensing.

In direct sensing, to detect current Ohm's law is used to measure the voltage drop occurred in wire when current flows through it. Current flowing through conductor causes a voltage drop. Relation between current and voltage is given by Ohm's law. So, current sensor detects current in wire or conductor and generates signal proportional to be detected current wither in form of analog voltage or digital output.

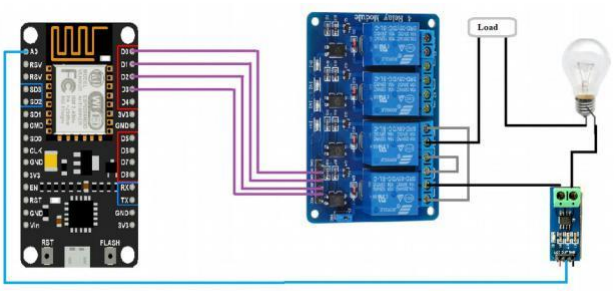
3. Relay

Relay is used to connect appliances and equipment channel needs a 15-20mA driver current. It can be used to control various appliances and equipment's with large current. It is equipped with high-current relays that work under ACS250V 10A or DC30V.

Relay closes at low level with indicator on, released at high level with indicator off. VCC is system power source and consists of input pins to accept instructions from an external source.

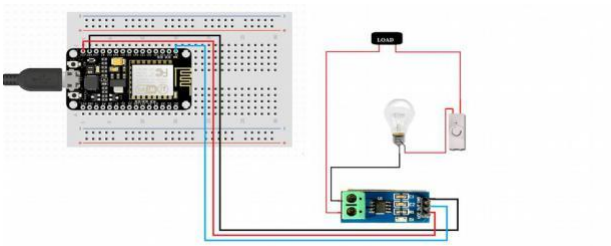
IV. Methodology

First circuit will tell about the black out or any energy loss situation that may be caused by any natural disaster or wiring problem.



Connection established is Node MCU with Relay. The output signal of ACS712 sensor is connected with A0 pin of Node MCU. 2 channels of relay are connected in 3 way switching. This allow to control the load from any of two channels. With ACS712 connected, we can get to know if we are getting signal from channels or not.

Second connection is to get information about current intensity, power usage, voltage status and reading input from the user.



The above diagram describes the layout of how the channels are layed out in Blynk. Channel status shows running as well as we can see the readings of passing current.

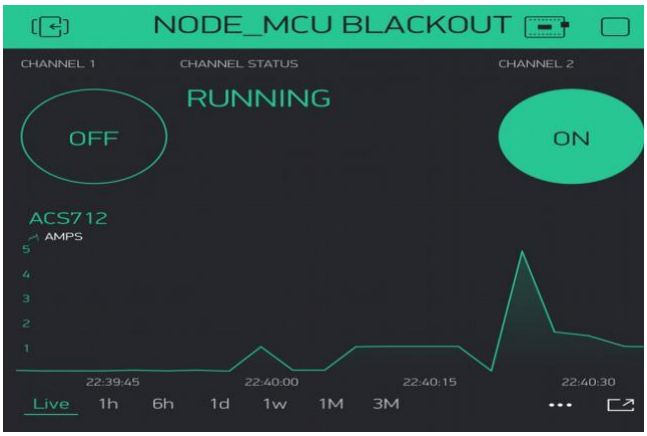
We can control passing current with either of the channel.

For the second circuit, we are checking about the current reading, load monitoring, voltage status and the bill generation. Bill is updated on hourly status. And we can also compare the status of the current and load.

ACS712 connected to A0 pin of Node MCU. Bulb connected to ACS712 and Voltage regulator. Regulator is to vary the voltage intake. This will allow to tell if incoming voltage is low, medium or high. To analyse the reading, we'll use Blynk IoT platform. Blynk is a mobile application that allows to connect to our hardware over internet. This will also allow us to control the hardware from the Blynk mobile application. We can also grab the readings from the sensor to our mobile application.

V. Result

Blackout status will tell if any channel looses connection. Two channels will be controlled with Blynk application and we'll read the output of the channels as well as the status of the channels.



VI. Conclusion

Comparative study and design of the smart grid will enable to use energy in a very efficient manner. With the help of renewable resources, peak hours can be reduced and energy distribution can also be done to very distant areas where still people are living without lights. This will also beneficial in terms of ecological and biological manner. With use of sensors and utilizing the internet will enable to monitor and analyzing in real time and in a very efficient manner. Consumer can analyze the usage for individual appliance and use them accordingly.

Future advancement in the model includes adding renewable resource like solar panel or turbine which produces energy and then storing it into a battery(lithium) connected. This energy will be used for future purposes like blackouts or grid failure.

Excess energy produced from the houses will be sent to the respective grid that will be utilized in distribution of energy. This will be a 2 way process in which the houses will be sharing their produced energy to the grid and the grid will be distributing this energy to other grid which are handling blackouts and other energy related issues. Further, advanced security measures can be taken to protect the organizations web application and mobile applications and protecting their consumers data like static ip configuration, data access control and advanced authentication mechanisms. More advanced SCADA system to monitor and analyse with data mining to efficiently record and manage the data. Securing the SCADA system with static ip configuration to make the system more secured.

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