DESIGN OF RASBERRY PI WEB – BASED ENERGY MONITORING SYSTEM FOR RESIDENTIAL ELECTRICITY CONSUMPTION

1.N. SHALEEN SAROJ, 2. B. VINEELA,3. M.SAI SRI,4. T. HEMA SRI

1.ASSISTANT PROFESSOR, 2,3&4.UG SCHOLAR

DEPARTMENT OF IOT, MALLA REDDY ENGINEERING COLLEGE FOR WOMEN, HYDERABAD

ABSTRACT

The goal of this project is to develop and deploy a web-based energy monitoring system for residential electricity consumption using Internet of Things (IoT) technology and various hardware elements, including a Raspberry Pi Pico, LCD display, current coil, relay energy meter PZEM004T, ESP8226, and RFID. The planned system will enable households to track their energy usage in real-time via a web-based interface, giving them insights into their energy usage habits and assisting them in finding ways to lower their electricity bills. The device will also compute the electricity rate depending on energy consumption and display it on the LCD screen. The hardware elements will cooperate to track and measure energy use, with the current coil identifying the power theft and give alert to the user via web server or via mobile application. An RFID tag and reader will be used for the purpose of prepaying option, that will display the amount which has been paid by the user. This web-based energy monitoring system will give households an affordable and practical tool to track their energy usage, prepaid amount, lower their electricity bills, and contribute to a more sustainable future.

INTRODUCTION

Over time, residential households' use of electricity has increased, resulting in rising electricity costs and environmental issues. Energy monitoring devices that enable households to track their energy usage in real-time and find solutions to lower their electricity bills are becoming more and more necessary to address these challenges. In this project, we suggest an Internet of Things (IoT)-based web-based energy monitoring system that makes use of a variety of hardware elements, including Raspberry Pi Pico, LCD display, current coil, relay 3.3, relay energy meter PZEM004T, ESP8226, and RFID, to measure and monitor energy consumption in residential homes. With a web-basedinterface, the system will enable homeowners to track their energy usage in real-time, giving them insights into their usage patterns and assisting them in finding ways to lower their electricity bills. Also, based on energy consumption, the system will determine the electricity rate and display it on the LCD panel. With the current coil monitoring the current flowing through the circuit and the energy metre PZEM004T measuring the voltage and power consumption, the hardware components will work together to measure and monitor the energy usage. The Raspberry Pi Pico will process and store the data after receiving it wirelessly from the ESP8226 module. Relay 3.3 will manage the power supply to the relay and the energymetre, ensuring that only the essential parts are turned on when required. An RFID card reader will be used to authenticate the user and guarantee that only permitted users can access the system. Users can check their energy use and tariff information on the LCD panel after swiping their RFID card to gain access to the system. Homeowners will be able to monitor their energy usage, lower their electricity costs, and contribute to a more sustainable future with the help of this web-based energy monitoring system.

LITERATURE SURVEY

Adnan Rashdi, Rafia Malik, "GSMBased Home Appliances Control System for Domestic Power Users in Ghana," IIT, 2012.

This paper presents design and development of a global system for mobile communications (GSM)-based energy monitoring, profiling and control system. The proposed system integrates consumer's digital energy meter with energy monitoring system which is controlled by electric supply company. Single phase or three phase digital electric meters can be used with indigenously developed add on module, which acquires energy usage data at consumer premises and after necessary processing transmits it to the electric supply company using short message service (SMS) and global packet radio service (GPRS) through GSM network. At the electric supplier end, an energy monitoring system manages all received meter readings, computes the billing cost, updates the database and maintains an energy consumption profile for each consumer. System controls all operations at the electric supply company headquarters and generates various warning alerts on occurrence of faults in the system. A working prototype of complete system has been developed using digital energy meter manufactured by

MicroTech Industries, Pakistan, to demonstrate an efficient and transparent means of automatic meter reading, billing and notification using existing wide spread GSM network.The conventional energy metering system requires the energy supplier company to send their representatives who manually read and record the energy consumption for billing purposes. The manual energy reading system suffers from a wide variety of disadvantages making it inefficient. The requirement of huge manpower to acquire meter readings is not cost effective and with human involvement, it is prone to human errors as well as tampering of records. This leads to non-transparency in the electric energy metering system. To devise an efficient and transparent metering system,the concept of automatic meter reading (AMR) and energy profiling system (EPS) evolved. It provides an effective means of energy consumption information collection and its analysis for accurate billing [1,2]. A plethora of technologies can be used for implementing meter reading system, but each technology has its own pros and cons [3]. Radio frequency (RF)-based meter reading systems make use of handheld devices, mobile and fixed networks [4]. Handheld device-based meter reading system uses a handheld computer equipped with RF transceiver to collect readings, but it does not make an optimum use of the AMR capable meters, as meter reading staff is still required. Mobile or drive-by meter reading is another approach which has an RF meter reading device installed in a vehicle to collect meter readings. Due to the short range of mobility, it again requires a team for collection of meter readings. AMR can also be implemented using power line communication (PLC) and telephone line network, but it has an inherent disadvantage of interference and noise, which deems it unreliable. Wi-Fi technology has also been used for transmission of metering information, but not being a widespread technology, it requires the installation of access points to cover the designated areas. A GSM-based AMR system has been shown in Fig. 1. GSM and GSM-Zigbee hybrid models for AMR have also been proposed in [5,6]. The proposed system has been indigenously developed to induce transparency in the current electric meter reading system. It facilitates low cost real time energy monitoring, profiling and control using SMS or GPRS provided by widely installed GSM network. The initial version of the system was developed and tested using SMS [7], whereas the system considered in this paper has been developed and tested for both SMS and GPRS. The developed automation leads to an efficient energy metering system which is transparent, without human errors and ideal for power distribution systems of developing countries. System allows bidirectional communication thus allowing energy supplier company to remotely control the consumer's electric meter and energy consumption profiling system is also accessible to users and the energy supply company. By incorporating control coupled with profiling, the developed system creates some degree of awareness among users, encouraging them towards conservation of energy. An additional feature added to the developed EPS is global positioning system (GPS) to indicate the location of consumers, helping to create traffic profile for energy suppliers. This can also be beneficial when used with sensors to indicate energy meter tampering/theft and thus reducing overall power loses.

Dr. D. S. Jangamshetti, and Dr. S. H. Jangamshetti, "Design, Implementation and Testing of Theft and Maintenance Monitoring of Batteries of Stand-alone SPV systems," IEEE, 2015.

This paper presents the use of solar energy for generation of electrical energy through solar photovoltaic (SPV) system to meet the load requirement of a domestic building. Complete design and economic analysis of SPV system for different costs of SPV module is done and compared with grid electricity for with and without storage conditions. The results of the study encourage the use of SPV system for a residential building and show that SPV system is an economically viable option to meet the exponentially growing electricity requirement for household applications in India.India faces a significant gap between electricity demand and supply. Demand is increasing at a very rapid rate compared to supply. According to the World Bank, roughly 40% of residences in India are without electricity. In addition, blackouts are a common occurrence throughout the country. The World Bank also reports that onethird of Indian businesses believe that unreliable electricity is one of their primary impediments of doing business. In addition, coal shortages are further straining power generation capabilities. In order to meet the situation, a number of options are considered. Power generation from freely available solar energy is one such option. Most parts of India receive bright sunshine around 3000 hours in a year except Kerala, northeastern states and Jammu & Kashmir where sunshine hours are appreciable low. During monsoon, a significant decrease in sunshine occurs over the whole country except Jammu and Kashmir where the maximum duration of sunshine occurs in June and July, and minimum during January due to its location. The northeastern states and southeast peninsula also receive relatively less sunshine during October and November due to the northeast monsoons. As far as the availability of global solar radiation is concerned,more than 2000 kWh/m2 /year are received over Rajasthan and Gujarat, while east Bihar, northwest Bengal and the northeastern states receive less than 1700 kWh/m2 /year. The availability of diffuse solar radiation varies widely in the country. The annual pattern shows a minimum of 740 kWh/m2 /year solar radiations over Rajasthan increasing eastwards to 840 kWh/m2 /year in the north eastern state, and southwards to 920 kWh/m2 /year. India is thus endowed with rich solar energy resource. The average intensity of solar radiation received in India is 200 MW/km2 . With a geographical area of 3.287 million km square, this amounts to 657.4 million MW. However, 87.5% of the land is used for agriculture, forests, etc., 6.7% for housing, industry, etc. and 5.8 % are barren, snowbound or generally inhabitable. Thus only 12.5% of the land area amounting to 0.413 million km square, in theory, can be used for solar energy installations. Even if 10% of this land can be used, the available solar energy would be 8 million MW, which is equivalent to 5909 million tons of oil equivalent. Launching India's national action plan on climate change on June 30, 2008, the prime minister of India Dr. Manmohan Singh stated "Our vision is to make India's economic development energy efficient. Over a period of time, we must pioneer a graduated shift from economic activity based on fossil fuels and from reliance on non-renewable and depleting sources of energy to renewable sources of energy. In this strategy, the sun occupies centre-stage, as it should being literally the original source of all energy. We will pool our scientific, technical and managerial talents, with sufficient financial resources, to develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people. Our success in this endeavor will change the face of India. It should also enable India to help change the destinies of people around the world." The economic viability of a standalone PV system in comparison to the most likely conventional alternative system, i.e. a diesel-powered system, has been analyzed for energy demand through sensitivity analysis [1]. The analysis shows that PV-powered systems are the lowest cost option at a daily energy demand of up to 15 kWh, even under unfavorable economic conditions. When the economic parameters are more favorable, PV-powered systems are competitive up to 68 kWh/day. These comparisons are intended to give a first-order indication when a standalone PV system should be considered for application. As the cost of PV systems decreases and diesel costs increase, the break-even points occur at higher energy demand. A methodology is presented [2] for determining the optimum size and location of installing the solar photovoltaic based DG system for supplying the active power at the node in a radial distribution system for loss reduction. Techno-economic feasibility of three different energy-supplying alternatives, namely the solar photovoltaic (SPV) system, diesel generator system and extending the grid connection for energy supply to a remote village located around 15 km away from the place where grid supply is available, is suggested [3]. The study suggests that the SPV systems are cheaper in remote villages where grid extension is costlier. Literature presents several studies on energy payback time and life cycle analysis of PV technologies. The analyses of the PV system with reference to a fuel oil-fired steam turbine and their GHG emissions and costs revealed that greenhouse gases (GHG) emission from electricity generation from the PV system is less than one-fourth that from an oil-fired steam turbine plant and one half that from a gas-fired combined cycle plant. From the life cycle energy use and GHG emission perspectives, the PV system is a good choice of power generation. However, it also indicates that large scale exploitation of PV could lead to other types of undesirable environmental impacts in terms of material availability and waste disposal [3]. Life cycle assessment of electricity generation by PV panels considering mass and energy flows over the whole production process starting from silica extraction to the final panel assembling, using the most advanced and consolidate technologies for polycrystalline silicon panel production is presented [4]. Briefly, the most important results of the analysis are the calculation of a gross energy requirement (GER) of 1494 MJ/panel (0.65 m2 surface) and of a global warming potential (GWP) of 80 kg of equivalent CO2 panel. The energy payback time (EPBT) has been estimated to be shorter than the panel operation life even in the worst geographic conditions. The results of the LCA support the idea that the photo-voltaic electric production is advantageous for the environment. The authors in [5] analyzed foreseeable technological advancements in current and emerging PV technologies over the next few decades are likely to lead to significantly lower per-kWh impact than the one that characterizes the current state of the art of the PV sector. A techno-economic analysis of standalone solar photovoltaic system has been presented [6]. In this work, complete analytical methodology for optimum relationship between PV array and storage battery capacity to supply the required energy at a specified energy load fraction is carried out. To estimate the performance of solar photovoltaic system the solar radiation utilizability concept and the monthly average daily PV array efficiency have been used. The techno-economic optimization of a PV system has been done by using levelized energy cost computation based on the total number of battery replacements (brp's) through battery life-cycle model. It has been found that energy load fractions as well as the number of brp's have a significant impact on the selection of optimum sizing of a standalone PV system. From the techno-economic and environmental points of view, the feasible sites in Egypt to build a 10 MW PV-grid connected power plant and recommended few sites for large scale PV power generation [7]. A techno-economic comparison of rural electrification based on solar home systems and PV micro-grids to supply electricity to rural community for domestic purpose has been performed [8]. Based on study it is concluded that a micro grid might be a more attractive option financially for the user, energy service company and the society if the village has a large number of households, which is densely populated and lies in a geo-graphically flat terrain and more than 500 densely located households using 3 - 4 low power appliances (e.g. 9 W CFLs) for an average of 4 h daily. However, in rough terrains solar home systems might be a better option if the community is small and sparsely populated. The economic analysis has been performed on the grid connected SPV system connected to the Spanish grid [9]. Using net present value (NPV) and payback period (PP) parameters, the profitability of the system was studied. The system was evaluated for its economic as well as environmental benefits and the results clearly showed that the system was profitable enough to be invested in, but very long payback periods were dissuading the investors. A strong case of standalone SPV systems has been built by conducting feasibility study in an island of West Bengal India by the name Sagar Deep based on socio-economic and environmental aspects. The generation costs of SPV systems and conventional power has been compared to show how conventional power systems suffer from diseconomy when power needs to be transmitted to extremely remote locations. The social viability of SPV was apparent from a conspicuous improvement in commerce, trade, education and increased participation of women in activities other than household chores in the island [10]. The paper uses the solar radiation data of a particular site for complete design and cost analysis of proposed Solar Photovoltaic (SPV) systems, to be installed in a building to supply electricity.

E. Effah, F. L. Aryeh, "GSM-Based Home Appliances Control System for Domestic Power Users in Ghana" Energy Efficiency, IEEE, 2016.

with the rising increase in population and its attendant increase in the consumption of energy, there is a great need toconserve energy in every way possible. The inability to access and control the appliances from remote locations is one of themajor reasons for energy wastage in Ghana. This project presents the development and implementation of a Global Systemfor Mobile Communication (GSM) based remote control system for electrical appliances and lighting that enables completecontrol of the interface on which it is based. GSM Shield was used for receiving Short Message Service (SMS) from the homeowner's mobile phone that automatically enables an Arduino microcontroller to take the necessary actions like switching OFF and ON electrical appliances such as fan, light, air-conditioner, supply mains and so on. Basically, it readsthe SMS and acts according to the message. Similar products commercially available are Internet dependent and so lack thetrue sense of real mobility and security. However, the present GSM-based remote control system allows the homeowner tocontrol household appliances from anywhere using the mobile phone and also prevents unauthorised access to theseappliances. Crucial to the present system is the provision of security on detection of intrusion via SMS using GSMtechnology. This GSM-based home appliances control system is recommended for implementation in every home to tacklethe rampant energy wastage in GhanaThe development of digital information has led tothe rapid change in human lifestyle. The use ofelectricity is very important as one of the mainsources of energy that is vital in modern lives. Asthe years go by, technology has been ever evolving,and as a result, new means are being developed foreasier and safer control of electrical devices formore efficient power management at homes andworkplaces.Most people inevitably tend to leave their lights ,fans and other appliances on when leaving theirhomes resulting in energy wastages andinefficiencies. It is not always feasible to be physically present or near the vicinity of the homeenvironment but whatever be the case, much effortshould be done to moderate energy wastage. InGhana, these wastages are very detrimental toindustrial development. Consequently, availabletechnologies need to be widened to eliminate orreduce these wastages in electricity usageNegligence with regards to leaving lights and otherelectrical appliances on can lead to outrageouselectricity bills, wastage of much needed power(electrical energy) and shorter life span of electricaldevices or appliances.This paper presents the design and implementationof a centralised remote lighting and appliancescontrol system for smart home applications usingGSM technology that generally reduces the cost of power consumption appreciably. This system isimplemented using a customised user friendlymobile application. This same system implementsintrusion detection, notification alerts and alarmfunctions.Recent energy crisis in Ghana and the entire WestAfrican sub-region justifies the need for the presentsystem because electrical energy is a limitedresource that is not readily available. Therefore, wecannot afford to abuse the very little we haveavailable. If we unintentionally leave any of thehome electrical appliances (TVs, fan, bulbs) on, weshould be able to access them remotely. Therefore,the remote controlling takes the control of thehome beyond the home and directly to the hands ofthe home owners. Basically, if a simple mobile phone takes on the added responsibility to controlthe electrical appliances of any home, then thecontrol has no geographical boundaries. The ever-increasing incline towards mobile services amongGhanaians makes it the logical choice whendeveloping a system which can control homeappliances and lighting from anywhere.

F. Abate , "Smart meter for the IoT," IEEE, 2018

In recent years, smart devices are increasingly. These devices allow making cities smart, enabling communication not only among people but also among things, creating a new system nowadays known by the term IoT (Internet of Things). A smart city is based on a smart grid that allows to intelligently manage the power grid. In order to do this, the network must have intelligent meters that can communicate bidirectionally with the network. This market has led to a proliferation of smart meters that give the opportunity to measure the consumption of each single device in homes. The most part of smart meters are based on a chip that calculates the parameters needed to estimate energy consumption. In this paper, the authors consider a smart meter based on a common chip that calculate the power consumption and the meter characterization is reported.The smart city [1] in urban planning and architecture is a set of urban planning strategies (see Fig. 1) aimed at optimizing and innovating public services so as to link the material infrastructures of cities "with capital human, intellectual and social lives of those who live in them" thanks to the widespread use of new technologies for communication, mobility, the environment and energy efficiency, in order to improve the quality of life and meet the needs of citizens, businesses and institutions [2]. Urban performance depends not only on the provision of material infrastructures in the city (physical capital), but also, and increasingly, from the availability and quality of communication, knowledge and social infrastructure (intellectual capital and social capital). This latter form of capital is particularly important for urban competitiveness.The intelligent city concept has been introduced in this context as a strategic device to contain modern urban production factors in a common framework and to emphasize the growing importance of information and communication technologies (ICT), social and environmental capital in defining the competitiveness profile of cities, moving towards sustainability and ecological measures both in control and energy saving, optimizing mobility and security solutions The significance of the two sets of social and environmental capital points to the need for a long way to go to distinguish intelligent or smart cities from those with a greater technological burden, drawing a clear line between them, what goes below the name of smart cities and digital cities respectively. The first thing to take into account, in order to have a smart city is to consider the smart grid opportunity. It is clear that the grid of the 21st century will be a "Smart Grid". Due of the global demand for worldwide electricity, and to the ground gained by renewable energy and distributed generation, most electric grids, designed and built decades ago, are now struggling to meet these new challenges. In this context, the study of smart grids is introduced, which provides the network of intelligent and optimized elements and configurations that can facilitate management operations. First of all, it should be specified that the experimentation pursues two different strands, namely network intelligence at national level and the creation of as independent networks as possible, the size of which varies according to initial production and consumption hypotheses. In the second line there are the most futuristic solutions, but already in the first there are important novelties that will revolutionize the way to consume energy of individual; one of the key assumptions in fact is in both cases centrality of the consumer, as the active protagonist of energy management and no longer as the end user of the production chain. In the middle of these two streets, the idea of smart cities is taken up, strongly encouraged by the more accurately and farsighted local governments, which consists in applying the concept of an autonomous network to the management area of a single city, and then providing the same links intelligent with other cities and the national network. The Smart Grid will be characterized by bidirectional data communication among all relevant users of the energy conversion chain [3], [4]. The result is a participatory network (as depicted in Fig. 2) in which consumers, utilities, and service providers share responsibilities and benefits [5]. In this scenario Smart Meters, capable of bidirectional data communication in the connection of consumers to the Smart Grid, are among the fundamental building blocks of Smart Grid deployments. At first, outage detection and power restoration and verification will be improved by smart metering. Mainlysmart metering solutions will help empower consumers with information to monitor, manage, and control energy usage and optimize performance and reduce energy losses. With smart-grid-enabled net metering benefits can be mutual: utilities could be able to manage peak demand, whilst consumers can monitor and optimize their energy consumption based upon the real-time price of energy and individual needs and offset rising power bills [6],[7]. The implementation of a Smart

Metering solution means that utilities will be able to offer better targeted tariffs and introduce new business models based on real-time pricing or active load control, which can be used to reduce high-cost consumption [8]. In order to unfold its full potential, Smart Metering requires an Advanced Metering Infrastructure (AMI) for full-scale bidirectional data communication to be in place. Data collected through an AMI can be captured, stored, and forwarded to a central computer. Moreover, AMI aims at an open system with a connection to the Home Area Network (HAN). Particularly relevant in this field is the OPEN Meter project, which aims to specify a comprehensive set of open and public standards for AMI.

M. Prathik, "Smart Energy Meter Surveillance Using IoT," IEEE Access, 2018.

Long-range wide-area network (LoRaWAN) has emerged as a key technology for Internet of Things (IoT) applications worldwide owing to its cost-effectiveness, robustness to interference, low power, licensed-free frequency band, and long-range connectivity, thanks to the adaptive data rate. In this contribution, an IoT-enabled smart energy meter based on LoRaWAN technology (SEM-LoRaWAN) is developed to measure the energy consumption for a photovoltaic (PV) system and send real-time data to the utility/consumers over the Internet for billing/monitoring purposes. The proposed SEM-LoRaWAN is implemented in a PV system to monitor related parameters (i.e., voltage, current, power, energy, light intensity, temperature, and humidity) and update this information to the cloud. A LoRa shield is attached to an Arduino microcontroller with several sensors to gather the required information and send it to a LoRaWAN gateway. We also propose an algorithm to compose data from multiple sensors as payloads and upload these data using the gateway to The Things Network (TTN). The AllThingsTalkMaker IoT server is integrated into the TTN to be accessed using Web/mobile application interfaces. System-level tests are conducted using a fabricated testbed and connected to a solar panel to prove the SEM-LoRaWAN effectiveness in terms of functionality, simplicity, reliability, and cost. The connectivity between the system and users is achieved using smartphones/laptops. Results demonstrate a smooth system operation with detailed and accurate measurements of electrical usage and PV environmental conditions in real-time.In this globalization era, the usage of renewable energy, particularly solar energy, is growing rapidly and becoming more popular either in the residential or industrial sectors (Kobylinski, Wierzbowski, &Piotrowski, 2020). Malaysia also takes an opportunity in this field by utilizing the free sources from solar energy to give benefits to citizens because the solar photovoltaic (PV) systems have accomplished a strong market growth over the last decade (Jabbar et al., 2018, Lorente et al., 2020). Solar energy is still not implanted widely throughout Malaysia; only several solar farms are deployed in certain areas, such as the Ayer Keroh, Sepang, and Gambang. The PV system can work as a stand-alone (off-grid) or grid-connected power system to convert sunlight into direct current (DC) electricity using PVs. The produced DC electricity will be used during the daytime to charge the battery using a voltage regulator to ensure the proper and safe charging of the battery (Al-Ali, et al., 2020). DC appliances can be supplied directly from the system, but alternating current (AC) appliances can be powered via a DC–AC inverter. During the nighttime, loads will be fed directly from the battery. The produced energy using PV has been increased as the total energy demand shows an increment; thus, PV is rapidly being an integral part of the generation systems globally (Ismael, Aleem, Abdelaziz, &Zobaa, 2019). In the case of the grid-connected PV system operation mode, the electricity is converted to AC and fed to the grid; thus, AC energy meters are sufficient to measure the supplied/consumed energy. However, in the case of the stand-alone off-grid system operation mode.

P.Amrithaa, P.Shorubiga, T.Thanoojan, T.Kartheeswaran, "Electricity Usage Monitoring and Alerting System," ICIT, 2019.

Electricity is one of the inevitable sources of energy in our day to day life. Almost every single device we use from the moment we wake up until going to bed is electrically powered. Meanwhile, there is always a problem of power scarcity in our country. It mainly depends on hydraulic power, and we don't have much rainfall nowadays due to climate change issues. Our government is trying to overcome it and also to ensure power supply to all the consumers of the country without interruption. Reduced power consumption will lead to overcome electricity scarcity. Many pieces of research to monitor and reduce electricity usage is done in the past. However, most of them help to reduce electricity by displaying the total electricity consumption for a month. The best solution for this problem is to find the total electricity units consumed by each device for a given period of time rather than calculated as a whole. We have developed a gadget that will sense the electricity units consumed by a particular device being plugged in and will wirelessly transmit the units consumed in real-time and stored on a database. The total units consumed by the particular device per month will be calculated and displayed. Two prototypes are designed for this research and were tested over a two-week period of time. These gadgets can be plugged into any sockets and will help to detect the amount of power consumption, used through the gadgetDue to the increased usage of electricity, there is a need for monitoring the electric devices and alert the consumer at the correct time. As a result of the rapid development of technology, many devices that need electric power to work are being invented every day. The devices might consume only a small amount of power for one-time use, but the fact is when we use it several times and have many such small devices, the power consumption will be increased eventually without our knowledge. This research will help them to know the power they consumed, and they will also get to know that their device is used more than they expected. This paper proposes an idea that allocates electricity units for each device in the house (per month); when the allocated amount reaches its limit, it will alert the user that a particular machine is running out of allocated units. Hence, the user can reduce the electricity usage of the device which is spent unwantedly and also be able to maintain their monthly electricity bill as planned. This idea does not only help to warn the user about the excess usage of electricity, but also the user gets to know how much electricity that they are using with each device and appliance in their house per month [1]. This monitoring system helps them to analyze the electricity misuse, and also to reduce the power wages. Precisely, this idea helps to maintain our electricity expenses in control. If each house in our country uses this idea, then the whole country can do electricity savings in the long runThe implementation of this idea needs the latest technology and methods for an effective output. We believe that the updated technological knowledge of the current trends in technology will help to come up with a smart solution. When the question raised that how to implement the idea, it was decided that the Internet of Things (IoT) perfectly suits this idea [3]. Because the

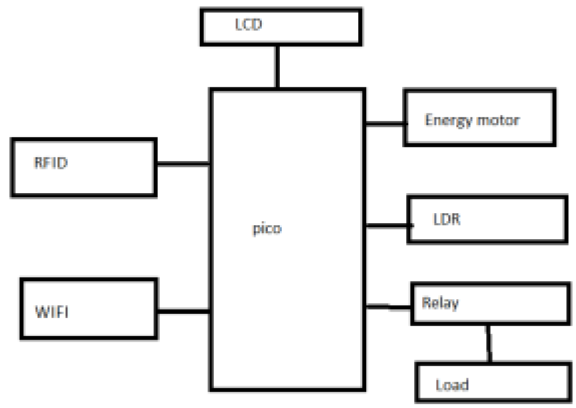
NodeMCU is the most common device used in the IoT based projects so far, and it is easy to use NodeMCU for our project. Therefore, we decided to move with this technology for implementation [4]. The electric devices use an electric current, which should be measured. Therefore, a current sensor must be used here to measure the electric current consumed by the devices. A microcontroller is needed to process the data collected from the sensor. The sensed data will be analyzed and will be displayed on a webpage where the users can access their accounts and view their subscribed details. The objective of this research is to produce a useful gadget that helps people to monitor the electricity of their house to control the extra electricity usage as well as the wages. Therefore, the product should be cost-effective to buy and used by almost every house in the country. For that, we did a feasibility study to find different ways in which the plan can be implemented, and we selected the best possible solution, which is durable, as well as cost-effective [5]. This system will allow the user to view the details of the electric units consumed and also facilitate to prepare a preplanned schedule of electricity usage. This will help to reduce the total energy consumption of a community and also reduce the regional and national electricity demand as a whole. If everyone knows their usage in more detail through our system, the general public can understand and will practice efficient mechanisms in electric power consumption in the future in the long run.

EXISTING SYSTEM

Smart meters are installed at residential locations to measure electricity consumption. These meters typically provide real-time data on energy usage. The smart meters communicate with a central server using various communication protocols, such as Zigbee, Wi-Fi, or cellular networks. The collected energy consumption data is stored securely in a database. Historical data is maintained for analysis and reporting purposes. Users access their energy consumption data through a web-based interface. The interface displays real-time and historical usage patterns, allowing consumers to track their energy consumption. Energy consumption data is often presented graphically, making it easier for users to understand their usage patterns. Charts, graphs, and visualizations help users identify peak usage times and areas for potential energy savings. The system may provide alerts or notifications to users for abnormal energy consumption patterns, helping them identify issues like faulty appliances or energy wastage. The system includes a tariff calculation engine that factors in the applicable electricity rates. Tariff structures can vary, including time-of-use pricing, tiered pricing, or flat rates. Secure user accounts are created, allowing individuals to access their personalized energy consumption information. User authentication and authorization mechanisms ensure data privacy Some systems provide energy-saving tips and recommendations based on users' consumption patterns. Integration with smart home devices allows users to remotely control and monitor energy-consuming appliances, contributing to energy efficiency. For users on a prepaid or postpaid system, the platform may integrate billing and payment features, providing a seamless experience for consumers.

IMPLEMENTATION

BLOCK DAIGRAM



Provide users with up-to-date information on their energy consumption. Visualize the data in an easily understandable format, like graphs or charts. Make sure the web interface is intuitive and user-friendly. Users should be able to navigate through the system effortlessly and understand their energy usage at a glance. If possible, integrate with smart devices and meters to gather accurate data. This could include smart plugs, smart thermostats, or any other IoT devices that contribute to energy consumption. Incorporate the current electricity tariff rates in your area to calculate the cost of energy consumption. You might also consider providing insights into how users can optimize their usage to reduce costs. Implement a notification system to alert users when their energy consumption is unusually high or if there are any changes in the tariff rates. Allow users to view historical data to identify trends and patterns in their energy consumption. This can be useful for making informed decisions about energy-saving strategies. Enable users to set preferences and goals for energy consumption. This could include budget constraints or sustainability targets. Given the sensitivity of energy consumption data, prioritize security measures to ensure the privacy and integrity of user information.

CONCLUSION

In conclusion, the suggested web-based energy monitoring system utilisingIoT technology and various hardware elements such as Raspberry Pi Pico, LCD display, current coil, relay, energy metre PZEM004T, ESP8226, and RFID is a practical and affordable solution for tracking energy usage in residential homes. The device enables homeowners to keep an eye on their energy usage in real-time and offers insights into their habits, enabling them to find ways to cut their electricity costs. On the LCD panel, the system also shows the electricity tariff that was calculated based on energy consumption. The gear works in unison to measure and monitor the energy usage, and the ESP8226 module wirelessly transmits the data to the Raspberry Pi Pico, which analyses and stores it. By managing the power supply to the energy metre and the relay, the relay makes sure that only the essential parts are turned on when they are required. An RFID card reader is employed to verify the user's identity and guarantee that only approved users can access the system. This adds another level of security to the system. This web-based energy monitoring system provides households with a useful and effective way to keep track of their energy usage, lower their electricity costs, and support a more sustainable future.

REFERENCES

1. Adnan Rashdi, Rafia Malik, “GSMBased Home Appliances Control System for Domestic Power Users in Ghana,” IIT, 2012.

2. Dr. D. S. Jangamshetti, and Dr. S. H. Jangamshetti, “Design, Implementation and Testing of Theft and Maintenance Monitoring of Batteries of Stand-alone SPV systems,” IEEE, 2015.

3. E. Effah, F. L. Aryeh, “GSM-Based Home Appliances Control System for Domestic Power Users in Ghana” Energy Efficiency, IEEE, 2016.

4. F. Abate , “Smart meter for the IoT,” IEEE, 2018.

5. Khadijah Alsafwan, Fatimah Alshaer, LolahHakami, KhawlahAseeri, MasoumahAlJishi, DilekDustegor, “iTrack: A Residential Energy Monitoring System Tailored to Meet Local Needs,” IC, 2015.

6. M. Prathik, “Smart Energy Meter Surveillance Using IoT,” IEEE Access, 2018.

7. P.Amrithaa, P.Shorubiga, T.Thanoojan, T.Kartheeswaran, “Electricity Usage Monitoring and Alerting System,” ICIT, 2019.

8. Rahul Rajesh.B, “IoT Based Automatic Energy Metering with Prepaid/Postpaid Configurability,” International Conference, 2017.

9. Savita, SumitShrivastava, Abhishek Arora, VikasVarshney, “Overvoltage and Undervoltage Protection of Load using GSM modem SMS Alert,” IEEE, 2018.

10. ZainalHishamCheSoh, IrniHamizaHamzah, “Energy Consumption Monitoring and Alert System via IoT,” Fi-Cloud, 2019.