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Review Paper on "Intelligent Energy Management"

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Abstract **Energy management is now a days is subjected to a great importance and complexity. Today there are lots of energy measuring devices in the market and also for monitoring. These power consuming devices can be of any sector that is household ,industrial, commercial. Many a times, consumers aren't satisfied with the bill as it does not show the power consumed at the device level. So with the new computer aided technologies where devices can be connected wirelessly leading to IoT, in this paper an IoT based Intelligent Energy Management system is introduced where appliances like Fan ,Bulb and other appliances can be monitored and controlled. This proposed system presents the design and implementation of an monitoring and controlling system using, Arduino nano microcontroller, IoT which can be used to measure and monitor the power consumed by any individual electrical appliance. The important motive of the proposed system is to monitor and control the power consumption as per the appliances.. The energy monitoring system calculates the power consumed by various electrical devices and displays it through a web server**

Keywords —Energy management, energy monitoring, electricity bill, time of us, connected appliances.

I. INTRODUCTION

As the demand for energy is increasing rapidly there is a need where we have to use alternative source for electricity generation but as there are many difficulties by renewable energy generation techniques. Energy management systems (EMS) are extensively used in all places for the sake of cutting down the electricity cost and also improve the energy efficiency. A modern updated system for the advancement of EMS is discussed in this paper[2]. This paper mainly focused about EMS in Educational institutions as they constitute of many laboratories, lecture halls and many energy consuming loads , which consumes enormous amount of power.

Especially in Higher Educational Institutions (HEI) the level of energy consumption is high due to various laboratory, classrooms and also different loads . Electricity costs constitute of major budget of an educational institution. It would be much better to cut down the electricity bill by using EMS. The proposed model uses a centralized energy management system that enables it to track energy consumption and performance at various time periods[5]. The electricity utilization of different appliances that is recording their electrical parameters such as current ,voltage, power factor, active and reactive power also the electricity usage per hour by the user web using IoT. The consumption is monitored by usage of energy used per load[2].

Energy monitoring at the end-use equipment level allows the consumer to have deep insight into his energy usage and hence enable the operator to make informed decisions to reduce operational costs while improving the system ecological profiles With the continuing evolution towards the smart grid and government incentives, there is a need for smarter energy management systems that are cost effective, promote the ability to save energy and are actively providing feedback to operators to help them reducing their energy consumption . The existing energy monitoring system in any sector usually take a single power reading from one panel board, but rarely emphasize the importance of feedback to that sector and commercial operators. To measure the energy consumption at individual end-use equipment level within an industrial or commercial facility, one would need to retrieve data from the mains that indicates the total amount of power consumed at the facility, and be able to analyze the contributing factors to its total power consumption . If the machine specifications within the facility are provided within a database, it is possible to disaggregate the data retrieved from the mains, and accurately predict which machine in the facility is contributing to how much of the overall energy consumption[1]. The overall goal of this concept is to develop a cost effective energy monitoring and management system (EMMS) that can provide useful feedback to the consumers on their energy usage for the purpose of energy conservation, to facilitate cost savings to the consumers, and to improve the energy utilization.

The proposed EMMS strives to show the operator their consumption as well as provide the cost of energy consumed by each machine when it is in use and provide

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feedback on operation scheduling to help limit their energy consumption[2]. The proposed EMMS will provide data feedback through measurements from a single point in the system within the commercial/industrial/residual facility to provide the operator with the ability to manage their consumption.

II. RELATED WORK

W.G. Morsi introduces two techniques first, the energy consumption of individual machines is identified. A graphical user interface and operation scheduling are developed and the feedback is provided to the operator through fuzzy inference system. The results reveal significant savings in consumed energy and in dollars over time through the application of the proposed energy monitoring and management system (EMMS) into industrial facilities in intensive energy sectors.

P. Dongbaare examines smart energy management systems for residential use that have been implemented and proposed a model that results in the management of energy consumption of household appliances during peak hours based on availability of renewable power sources. Moreover, a smart algorithm that will switch between the various power sources to improve the Distributed Energy Resource (DER) and increase the profit of DER is discussed, as well.

M. Cirrincione presented a system able to self regulate a heterogeneous set of power sources and loads organised as a coherent group of entities that is called microgrid, in order to optimize several criteria such as: cost and efficiency. This system is based upon the Multi-Agent Systems paradigm. Each micro-grid entity is modelled as an autonomous agent able to interact and with it owns decision making mechanism. It takes into account the characteristics of the source or load types it belongs to and self-organizes with other agents in order to globally optimize the given criteria.

Paulo Bandarra analyses the procedures of selection and installation of equipment that are the basis for energy monitoring, with accuracy and technical quality, essential to the liability of the collected data. These energy management systems depend directly on data analysis, which involves the installation of measuring and monitoring equipment. The visualization of equipment consumption estimates helps to optimize the energy consumption cycle and allows the analysis of the data available in order to take preventive or corrective measures that reflect the correct characterization of the installation.

Abel Avitesh Chandra focused on solving the issue of on-site monitoring and control of diesel generators through online monitoring to have actual observation of basic parameters of a running diesel generator using readily available resources which are also cheap to setup and maintain. The work is investigated using the platform of Internet of Things (IoT) which is a very versatile technology in regards to the digital age in terms of interacting with environment and things. This paper looks into exploring the monitoring and control of generator using the power of IoT paradigm.

Tapan Shah reveals the functional expectation of the dc microgrid, system architecture, communication structure and distributed grid intelligent system The recent technology update in dc microgrid system. He also discussed the benefits and challenges of using dc grid.

Carmine Landi proposed a low cost real-time ARM-based energy management system . It is conceived as part of a distributed system that measures the main power system quantities and give the possibility to manage the whole power plant. An integrated Web Server allow to collect the statistics of power consumptions, power quality and is able to interface devices for load displacement. The device is characterized by easy access to the information and the combination of a smart meter and data communication capability allow local and remote access. In this way it is possible to manage the power consumption of the power system leading to an overall reduction in consumption and costs.

III. ENERGY MANAGEMENT SYSTEM

Energy Management System (EMS) is a system which makes use of computer-aided tools/software for monitoring, controlling and analyzing the performance of the generation, transmission and load consumption[2]. The computer technology used is also known as EMS/web server. The measurement, monitoring and controlling of energy use includes the installation and development of specific hardware and software in order to measure the performance of various loads used in any of the sector. EMS improves the efficient use of electricity, contributes towards conservation of energy resources and indirectly reduces the emission of greenhouse gases. The energy management system should be capable of monitoring and be controlling the devices in aggregation with cooling appliances. Energy costs are higher during peak load periods than normal load periods. In order to stabilize load during peak load periods a proper technique should be implemented. This model ensures the consumption of energy among all the devices based on their priority, especially during the peak-load situation. The presented model in this paper can be erected via wired communication and also wireless communication. Wireless communication model is cost effective and requires no cables and complex design in hardware.

IV. ENERGY MEASUREMENT AND MONITORING

The measurement and monitoring of energy use involves the installation and development of specific hardware and

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software in order to measure the performance of various electric, water and gas equipment with a good approximation, in order to characterize globally, and also to disaggregate the consumption of an installation[8]. It is possible to increase the energy efficiency of an installation with effective monitoring of energy consumption, by identifying the energy peaks and their causes, the misuse of energy, less efficient equipment and defects found. It is a powerful information tool or power service for a user/company wishing to analyse and identify the opportunities of rationalization of energy consumption. Monitoring allows the estimate of the amount of energy used, its immediate cost and environmental impact and should trigger an energy-awareness culture, encouraging consumers to adopt behaviour changes, to reduce consumption and hence reduce energy bills. The results can be quite useful for different entities, including the final consumer himself (receiving the consumption pattern and identifying possible interventions to save energy), managers of energy audits for certifications, public entities, service buildings, industry and even equipment manufacturers.

V. PROPOSED METHOD

This paper proposes a Intelligent Energy Management System which senses the current values on real time basis, computes the instantaneous power and uploads the values to the server using the Wi-Fi module. This Energy Monitoring System will monitor power consumption of devices connected in the network and update this information on server. Depending up on energy consumption and need of keeping particular device ON/OFF user can switch ON/OFF any device in the network. In this system every device or application is getting power supply through current sensor. Current sensor ACS712 will sense the current flowing through it and will send this data to arduino. Arduino will update this information on sever page where user can see power consumption of various devices after refreshing the page. Also depending up on need of keeping device ON/OFF and power consumption user can switch ON/OFF any device. The power consumption data on webpage will be updated automatically by refreshing the webpage.

A. Arduino Uno

Act as a microcontroller, the central controller for the whole unit of smart cart. Arduino Uno based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. The board can be programmed with Arduino Software (IDE). The board can operate on an external supply from 6 to 20 volts[12]. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The ATmega328 has 32 KB flash memory. It also has 2 KB of SRAM and 1 KB of EEPROM.

B. ESP8266

An esp8266 is a microcontroller. It is loaded with features. The most important being wifi. The best part is that they are dirt cheap and more powerful than an arduino. There is a variety of programming resources for these chips. It can operate at a supply voltage of 3.3volts. It is a chip with which manufactures make wireless microcontroller modules. It is a low cost,networkable foundation for facilitating IoT development. It can be simply hook up to arduino and can get about as much wifi connectivity as a wifi shield offers. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack. It has 1MB Flash Memory[4].

B. Current sensor

The current sensor is the main part of the circuit.. A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path. Current measurement is of vital importance in many power and instrumentation systems. Connect the sensor in series to the system whose current you want to measure, since current can be measured only in series. Here we are making use of ACS712 current sensor. The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die.It measures the magnetic field surrounding a conductor through which current passes. Generated magnetic field is then used to induce proportional voltage or current which is then transformed to a form suitable for measurement and/or control system.The output voltage thus produced is then given to the microcontroller Arduino through the Analog to Digital Converter (ADC) input. The precise formula for measuring current is Current = (AcsOffset - (Arduino measured analog reading)) / Sensitivity AcsOffset is normal voltage output at Viout pin when no current is flowing through the circuit. Arduino Analog read is the analog signal value read and converted to actual voltage from the analog channel to which acs712 output is connected. Sensitivity is Acs712 change in current representing 1 Ampere.

D. LCD A liquid-crystal display (LCD) is optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and indoor and outdoor signage[3]. Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. Results are displayed on LCD.

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E. RTC

A real-time clock (RTC) is a computer clock that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time[3]. RTCs often have an alternate source of power, so they can continue to keep time while the primary source of power is off or unavailable. This alternate source of power is normally a lithium battery. It is used so that we can get to know if the product is expired.

F. Drivers

A relay driver is a circuit required to drive a relay. A relay is used to switch ON/OFF of the device. A relay has two stable states either energised or de-energised. Relays are actuated when there is a change in the status on the webpage.

VI. CALCULATION USED IN BILLING OF ENERGY CONSUMED

Consumers are unaware of the cost of the energy used by electronic devices and the various load they use in their daily life. In fact, the electricity cost often exceeds the equipment's purchase price within a year. Simple calculations reveal the energy costs of a device and encourage conservation. In most communities, energy costs are not constant. Some utilities even charge by time of day, with lower rates during off-peak hours. Energy Meters are used for recording the power consumption. The consumption of Electricity is recorded in unit of Kilowatt Hour also called as units. One Kilowatt Hour or one unit is equivalent to running an appliance of 1 Kilowatt (or 1000 Watts) for 1 hour. The units consumed are calculated by observing the readings and then they are adapted to a common slab based tariff structure to come up with energy or electricity charges[3]. The tariff structures for domestic consumers are designed in such a way that per unit charge is more if the consumption is high. So the power charges increases significantly if the consumption of electricity is high.

For instance, if the consumption is 600 units in a month, then the electricity bill will be computed as: For first 100 units at RS.1.50 = RS.150 For next 200 units at RS.3.00 = RS.600 For next 200 units at RS.4.60 = RS.920 And final 100 units at RS.6.60 = RS.660 Charges are mentioned in Indian Rupees (INR). From the above example, it is clear that the consumption of electricity is high then the charges also increases correspondingly based on a fixed tariff.

Units	Tariff Charges		From	To	Cost (INR)
	Fixed	Subsidy			
≤ 100	₹ 0	₹ 150	1	100	1.50
≤ 200	₹ 20	₹ 150	1	200	1.50
≤ 500	₹ 30	₹ 150	1	100	1.50
			101	200	2.00
			201	500	3.00
> 500	₹ 50	₹ 150	1	100	1.50
			101	200	3.50
			201	500	4.60
			> 500		6.60

VII. CONCLUSION

Less and effective power consumption is the main design aspect of this paper. This paper presents the implementation of a portable energy management system which can monitor and control the power consumption at device level or globally anywhere with the system. The Computer aided tools and technologies are used for Energy Management that is described in this paper and their applications in any sector/institutions or energy use appliances . The application of this system can transform the normal sector in energy use into a green organization with optimized utilization. The utilization of energy generation capacity is optimized and the use of renewable energy sources is encouraged by implementing this model.

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