Major Project Report
On
ENERGY MONITORING SYSTEM

VIIIth SEMESTER

INFORMATION TECHNOLOGY

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Academic Year 2019-20
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CERTIFICATE

Certified that this project report "**ENERGY MONITORING SYSTEM**" is the bonafide work of "**TARUN PATHE, PAWAN UKEY, DARSHAN DHONE**" who carried out the major project work under my supervision in partial fulfillment of VIII Semester, Bachelor of Engineering in **VIII SEMESTER INFORMATION TECHNOLOGY** of RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR.

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ACKNOWLEDGEMENT

Our major project is titled, "**ENERGY MONITORING SYSTEM**". Any project requires a lot of hard work, sincerity and systematic work methodologies. We express our deepest gratitude to our Project Guide, **PROF. HEMLATA SAHU**, for giving us an opportunity to be a part of this project seminar and for the guidance, provided throughout the span of our project.

We would also like to thank **Prof**. **M. V. BRAMHE,** Head of the Department of Information Technology and all our faculty members who regularly evaluated our first phase of project and pointed out the shortcomings in the projects. They also gave us important feedback for the further improvement of our project. We are highly indebted to them.

We are also grateful to the industry mentor, Mr. **Nilesh Sahare, Chief Executive Officer, ANV InfoTech Pvt. Ltd, Nagpur** and alumni mentor, **Ms. Manali Thakre**, for their immense support throughout the project completion process. We are highly obliged to them.

We are also grateful to the **Management of the College, Dr. SURENDRA GOLE,** Principal & **Prof. R.B. GOWARDHAN,** Vice Principal for the overwhelming supporting providing us the facilities of computer lab and other required infrastructure. We would like to thank our Library Department for providing us useful books related to our project.

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ABSTRACT

The Internet of things is the network of devices such as vehicles, and home appliances that contain electronics, software, sensors, actuators, and connectivity which allows these things to connect, interact and exchange data. It which can sense, accumulate and transfer data over the internet without any human intervention. The benefit of the Internet of Things (IoT) and connected nodes has been on a steep incline in recent years.

An Energy Management System (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system. Energy monitoring is the best way to ensure that your home PV system generates properly and that you save on energy bills. An EMS provides the processes and systems needed to incorporate energy considerations as well as the energy management into daily operations as part of an organizational strategy for improving energy performance.

Energy monitoring is the key to the control and reduction of energy consumption in an organization. The energy resource management is a major concern worldwide. With energy monitoring system, track live power consumption in real-time for single or multiple devices. Identify abnormal patterns of energy use, pointing to imminent problems of numerous appliances. Discover and reduce your carbon footprints.

An energy audit is an inspection survey an analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output. Energy audit is an effective tool in defining and pursuing comprehensive energy management program.

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1. INTRODUCTION

1.1 OVERVIEW: -

Reducing the energy consumption is a major concern faced by industries worldwide to improve the economic performance while to reduce its CO2 footprint, and monitoring the energy usage at the component level is essential. This paper presents a design of an IoT (Internet of Things) based interactive system which combines non-invasive sensors and data acquisition apparatus, robust communication networks, clouds-based databases and web servers to achieve real-time monitoring of energy usage in industries. The collected energy consumption data are published to the data center automatically through the wireless communication network using the MQTT protocol, while a web server driven by Apache is developed to provide a human-data interaction dashboard in B/S (Browser I Server) structure. The system can not only assist industrial energy management but also provide a platform to improve energy-saving, emission reduction, along with other potentials. The system has been implemented in a local bakery company, confirming its applicability for remote real-time monitoring of energy consumption in the industry.

Energy audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating and maintenance practices of the system. Energy Audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating & maintenance practices of the system.

Energy audit generally has three steps: _

1. Preparation: - Information gathering stage.
2. Survey: - Review & analysis of the building based on the information gathered, the operating parameters & condition of equipment, occupancy data, processes involved & data collection through meters.
3. Report: - Data is analyzed based on which a report with recommendations is submitted.

Energy costs are soaring and your business can be at considerable risk if you do not take the guesswork out of your energy usage and the budget you need to cover it. Energy audits identify where your business is wasting energy. Residential and commercial properties account for around 10% of carbon emissions in the US, according to the EPA, which means they are very in efficient and waste huge amounts of energy and… revenue. An energy audit helps by revealing just how and where energy is being wasted.

Highlights: -

• IoT platform for the management of energy data in buildings.

• Includes several inner features to support data analytics in the energy domain.

• Based on the open IoT initiative EMS.

The INTERNET OF THINGS (IoT) has been considered as a tool that could bring great opportunities for energy reduction via the accurate monitoring and control of a large variety of energy-related agents in buildings.

However, there is a lack of IoT platforms specifically oriented towards the proper processing, management an analysis of such large and diverse data. In this context, we put forward in this paper the IoT Energy Platform which attempts to provide the first holistic solution for the management of IoT energy data. The platform we show here (that has been based on FIWARE) is suitable to include several functionalities and features that are key when dealing with energy quality insurance and support for data analytic.

Knowing your consumption is a prerequisite for conserving energy and preserving the environment. This is the first step in professional energy management and forms the basis for estimating savings potential and verifying the results of initiatives once implemented. Energy Monitoring involves the systematic and periodic monitoring of energy consumption, adjusted for changes in temperature, production levels, air quality and other cost drivers. Eneas offers a web-based Energy Monitoring System (EMS) adapted to property portfolios of all sizes and complexities. The system is set up with automatic and/or manual logging of data.

Energy costs are soaring and your business can be at considerable risk if you do not take the guesswork out of your energy usage and the budget you need to cover it. Energy audits identify where your business is wasting energy. Residential and commercial properties account for around 10% of carbon emissions in the US, according to the EPA, which means they are very in efficient and waste huge amounts of energy and revenue. An energy audit helps by revealing just how and where energy is being wasted.

1.2 PROBLEM STATEMENT: -

Electricity supply is fundamental in all business and production processes, such as in department stores where they are expected to maintain their lighting, cash registers and other equipment that are critical to store operation. Monitoring energy usage in commercial applications is a field that has arisen due to the need for industry to have a knowledge of the machinery that is being used and know

exactly what the real power consumption is for each process and equipment. An energy monitoring system is better than hiring energy consultants because it is a system that monitors 24/7 and does not have human error. The advantages of using a monitoring system to control electricity consumption.

Monitoring and keeping tracking of your electricity consumption for verification is a tedious task today since you need to go to meter reading room and take down readings. Well it is important to know if you are charged accordingly so the need is quite certain. Well we automate the system by allowing users to monitor energy meter readings over the internet. The meter is used to monitor units consumed and transmit the units as well as cost charged over the internet using Wi-Fi connection. This allows user to easily check the energy usage along with the cost charged online using a simple web application. Thus the energy meter monitoring system allows user to effectively monitor electricity meter readings and check the billing online with ease.

1.3 AIMS AND OBJECTIVE: -

The fundamental goal of energy monitoring is to produce goods and provide services with the least cost and environmental effect. the strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems. Energy audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility.

The objective of energy monitoring is to achieve and maintain optimum energy procurement and utilization throughout the organization, and:

- To minimize energy costs/waste without affecting production and quality.
- To quantifies energy usage according to its discrete functions.
- improving energy efficiency with cost–benefit analysis and an action plan to reduce energy consumption
- monitoring and analysis of use of energy including submission of technical report containing recommendations
- translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.
- The primary objective of energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs.
- the basis for planning a more effective use of energy throughout the organization.

- In general, there are three major categories of large-scale energy storage technologies: power quality, bridging power, and energy management
- Continuous improvement in the offshore industry's safety and environmental records
- Collaborate with industry in efforts that promote the public interests of offshore worker safety and environmental protection.

1.4 ORGANIZATION OF REPORT

The project report is organized in chapters, each of which has a unique title along with contents related to each title.

In chapter-1, we have the introduction to the project in which it provides an overview of the project.

In chapter-2, we have the review of literature which has an account of previous work done and need of proposed system in the field of energy monitoring system.

In chapter-3, covers the analysis, modeling and design of the project.

In chapter-4 covers the conclusion & future scope of the project.

Energy management is the key to saving energy in your organization. Much of the importance of energy saving stems from the global need to save energy - this global need affects energy prices, emissions targets, and legislation, all of which lead to several compelling reasons why you should save energy at your organization specifically.

2. REVIEW OF LITERATURE

2.1 INTRODUCTION: -

A literature review is an evaluative report of information found in the literature related to your selected area of study. The review is written so that it should give a theoretical base for the research and help you to determine the nature of your research. When conducting research, a literature review is an essential part of the project because it covers all previous research done on the relative problem statements and sets the platform on which the current research is based. No new research can be taken seriously without first reviewing the previous research done on the topic.

The use of technology has become an essential part of improving lifestyle, work efficiency, and a catalyst for economic growth. This paper aims to research, build, test and implement a low-cost energy monitoring and control system using IoT devices. The end goal is to observe energy efficiency by monitoring and controlling air conditioning appliances and standard overhead lighting units. [1]

With pressure mounting to reduce consumption and improve sustainability, a new generation of electricity monitoring devices has emerged to address the challenge. Tiny, wireless electricity sensors do the job of $1,000 electricity sub-meter, but they cost just $50 apiece. You will be able to see a complete picture of your energy consumption – every fan, motor, pump and circuit. And – as an added bonus – these sensors keep track of machine health and alert you to potential failure before it occurs. “Energy management” is a term that has a number of meanings, but we're mainly concerned with the one that relates to saving energy in businesses, public-sector/government organizations, and homes.

The global need to save energy If it wasn't for the global need to save energy, the term "energy management" might never have even been coined Globally we need to save energy in order to Reduce the damage that we're doing to our planet, Earth. As a human race we would probably find things rather difficult without the Earth, so it makes good sense to try to make it last. Reduce our dependence on the fossil fuels that are becoming increasingly limited in supply.

2.2. LITERATURE SURVEY: -

In this paper, Shahzeen Z. Attari has explained Multi-appliance power disaggregation technology implementers implemented the linear detection algorithm to determine which appliances are active in their power contributions. Problems are robust to errors in this database. using cloud computing technology found the solution for efficiency calculation of individual equipment. This paper 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. Energy efficiency plays a key role in the development of modern societies. Environmental concerns combined with the high-energy costs have a direct impact on the economic development of communities. The intensive energy consumption is currently a major concern and all sectors of activity can act to reduce consumption, increase efficiency and productivity. The sustainability of the economy in each country is directly related to its energy dependence and all mechanisms should be used to identify waste and find energy conservation opportunities. [1]

In this paper, Chunchi Gu has explained Energy audits, imposed on intensive energy consumers and energy management systems (EMS), implemented by any company, are tools whose objectives are energy characterization and rationalization of consumption in a facility. These tools may be used to analyze just the bills of electric power or, in a more complex way, the bills and the monitoring logs. 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. [2]

In this paper, P. Thamari, R. amudhevalli has explained using three feedback system, monitored the energy in residential Real-Time. It is critical to the continuing engagement and use of the device to save energy. Residences to determine the feedback provided by real-time energy monitors results in lower residential consumption rates during the 30 days after installation. Because of increased power consumption and exhausted natural resources, more and more energy policies as well as R&D projects have been in progress in several countries. But most of them seem to be in the beginning or no business. It is due to their unreality, inefficiency or complexity. In this paper, we focus especially on the home energy consumption, and propose a simple and effective scheme so as to reduce the waste of power in the home. Home energy management system (HEMS) which we developed adopts plain energy management mechanism, so it can be realized more easily. It requires user's minimal decision and action for correct judgment. It also uses Automatic Meter Reading (AMR) network based on power line

communication (PLC). We installed and verified HEMS in the real customers' houses, and got meaningful result for saving energy - significant power reduction. [3]

In this paper, Mahmoud Saleh and Yusef Esa has explained GREEN technology is the smallest Zig bee-compatible node in existence. This technology will possible in every place sensing of a different data types, from energy metering to environmental monitoring. As home energy use is increasing and renewable energy systems are deployed, home energy management system (HEMS) needs to consider both energy consumption and generation simultaneously to minimize the energy cost. This paper proposes a smart HEMS architecture that considers both energy consumption and generation simultaneously. ZigBee-based energy measurement modules are used to monitor the energy consumption of home appliances and lights. A PLC-based renewable energy gateway is used to monitor the energy generation of renewable energies. The home server gathers the energy consumption and generation data, analyzes them for energy estimation, and controls the home energy use schedule to minimize the energy cost. The remote energy management server aggregates the energy data from numerous home servers, compares them, and creates useful statistical analysis information. By considering both energy consumption and generation, the proposed HEMS architecture is expected to optimize home energy use and result in home energy cost saving. [4]

In this paper, G. Kabir, A. I.Abubakar has explained Wi-Fi technology application that can develop for Apple and BlackBerry 10 OS, thus providing multiple platform users support. Wireless sensor and actuator networks (WSAN) integrated with computer intelligence have recently been proposed for a large range of applications for energy management systems. This paper presents an original smart platform for Home Energy Management System, which embeds computer intelligence for optimization of the power consumption of controllable appliances based on retail pricing schemes, knowledge representation by classification rules of different appliances and decision trees based on their consumption behavior, without disturbing the living comfort of the home owners. In 2017, using IOT technology an IoT device was created for measuring the voltage, current, power and energy of a three-phase four-line power line in a laboratory building. [5]

2.3. FEASIBILITY STUDY: -

Using affordable electronic circuits, electronic appliances and IOT technology, this project can be made economically, technically and operational feasible.

Economic Feasibility:

Energy monitoring system (EMS) is based on web page and android phone application. This system uses component such as microcontroller, sim module 808, Modbus-2-RS232 convertor, SMPS, which are having less cost this makes the system economically feasible to implement. thus the total cost of Energy monitoring system is moderate.

Technical Feasibility:

Technical Feasibility is a measure of the practically of specific technical solution and the availability of technical resources and expertise. The proposed system uses Embedded ‘C’ or hardware coding with HTML, JS or CSS for web page designing as front-end and MS SQL server as back-end tool.

3. PROPOSED SYSTEM

3.1 DRAWBACKS OF CURRENT SYSTEM AND NEED OF PROPOSED SYSTEM: -

DRAWBACKS OF SYSTEM

- **Partially automated:**

The main disadvantage of energy monitoring system is that; it is not fully automated. The readings taken by the system are not analyzed automatically. We need to manually read and analyze all the readings taken by the system, to make further changes in the conventional system.

- **Manual interference:**

There is a need of human to interfere in this system manually. The system is not capable of changing the over power consumption on its own. So we need to make changes in the load manually.

- **Network dependent:**

This system is network dependent. if there are network issues in local area, the system will be disconnecting or the system may have lags in it. Because of this, the system will not have been implemented
In rural area.

- **Cost:**

Even though the price of Energy Monitoring systems has become much more affordable in recent years, the cost to purchase and install a device can still add up, Maintenance cost is also high. Consumer Reports offers a wide range of information and insights – including costs – on the Energy Monitoring systems in the market.

NEED OF SYSTEM:

- **Industry:**

In the industry, there is huge amount of energy consumption. To reduce the excess use of energy, Industry should analyze the energy audit and accordingly stop the wastage of electricity to reduce excess use of electricity.

- **Home System:**

In the local area houses or in the home society where huge amount of electricity has been used, Energy monitoring system can be used to control the excess use of electricity.

- **Remote System:**

In this days, people has a lot of works in their respective workplaces, they will not use to live in the home always. As Energy monitoring system provide remote monitoring system, people can always have connected with their homes remotely.

3.2 SYSTEM DESCRIPTION AND SRS: -

The rapidly growing energy consumption has raised concerns over exhaustion of energy resources and its impacts on the environment. The global contribution towards energy consumption of the developed countries including residential and industrial sector has steadily increased from 20% to 40%. For this reason, it is of utmost importance to manage and monitor the energy consumption and making it cost efficient for small and large scale industries, as industrial sector contributing the higher rate of energy consumptions. Therefore, the system is proposed to remotely manage and monitor the Energy utilization considering various parameters and generating the reports, log data for analytics. Thus, reducing fault logs providing live alerts by real time monitoring with a better performance and efficiency, finally reducing the cost. The approach is to ensure a robust system on aspects such as measure, store and report via high quality components and redundancies in the system design.

3.2.1 PURPOSE

The main intention of this project is for monitoring various electrical loads remotely over internet using Internet of Things (IOT). The smart phone android application with user configurable GUI front end can be used for real-time scenario. Using Energy Monitoring system electricity will be saved, And the excess use of electricity has been stop. It is also made to provide remote management system so that user can monitor the real time use of electricity remotely from anywhere in the world. the electrical loads are monitored and the status of power consumption is displayed on the web page or in the app.

3.2.2 PROJECT SCOPE

The scope is to create a prototype environment. This prototype shall be used to further develop the lab, as well as initiate interest in energy monitoring system. The system is a full-sized, interactive environment that incorporates technology to assist in power consumption of Daily Living basis and is

subject to the regulations and constraints placed on the system.

3.2.3 PROJECT PLANNING

There are so many options available to industry owners when it comes to planning an energy monitoring system.

1. Who is the system for?

Firstly, you need to establish who the system will be used by just yourself, the whole family or a client. Establishing who the system is for will enable you to get a grip and start to detail what is required across the industry. Discuss the system with your family, asking them when it comes to technology what kind of features or you don't want, you would like and what you must have.

2. Decide what parts of your industry you want to control the use of energy

When energy monitoring system is applied to the industry, you will get the real time consumption of electricity in the form of graphical representation with the help of energy audit. In the industry sometimes use of energy becomes higher then you need to configure, where the excess of energy is being used with electrical appliances such as fan, TV, lights, computers, machinery, etc.

3. How do you analyze energy audit?

After applying Energy monitoring system in the industry, you will get the real time energy consumption representation. Then you need to analyze where the excess of energy is being used further you can limit the energy consumption in that area.

Sr. No.	Task		August				September				october			
			week 1	week 2	week 3	week 4	week 1	week 2	week 3	week 4	week 1	week 2	week 3	week 4
1	Communication with industry mentor													
2	Domain and topic discussion													
3	Project finalized													
4	Information gathering													
5	Research paper study													
6	Planning													

Fig 3.2.1 Gantt chart

3.2.4 WORK BREAK DOWN STRUCTURE:-

TASK NO.	TASK	DURATION
1.	DISCOVERY	7 days
2.	PLANNING	10 days
3.	LITERATUR ESURVEY	5 days
4.	SRS	7 days
5.	SYSTEM ANALYSIS	20 days
6.	SYSTEM DESIGN	25 days

3.3 SYSTEM ANALYSIS: -

It is a process of collecting and interpreting facts, identifying the problems, and decomposition of a system into its components. System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives. It is a problem solving technique that improves the system and ensures that all the components of the system work efficiently to accomplish their purpose.

3.3.1 SYSTEM ARCHITECTURE: -

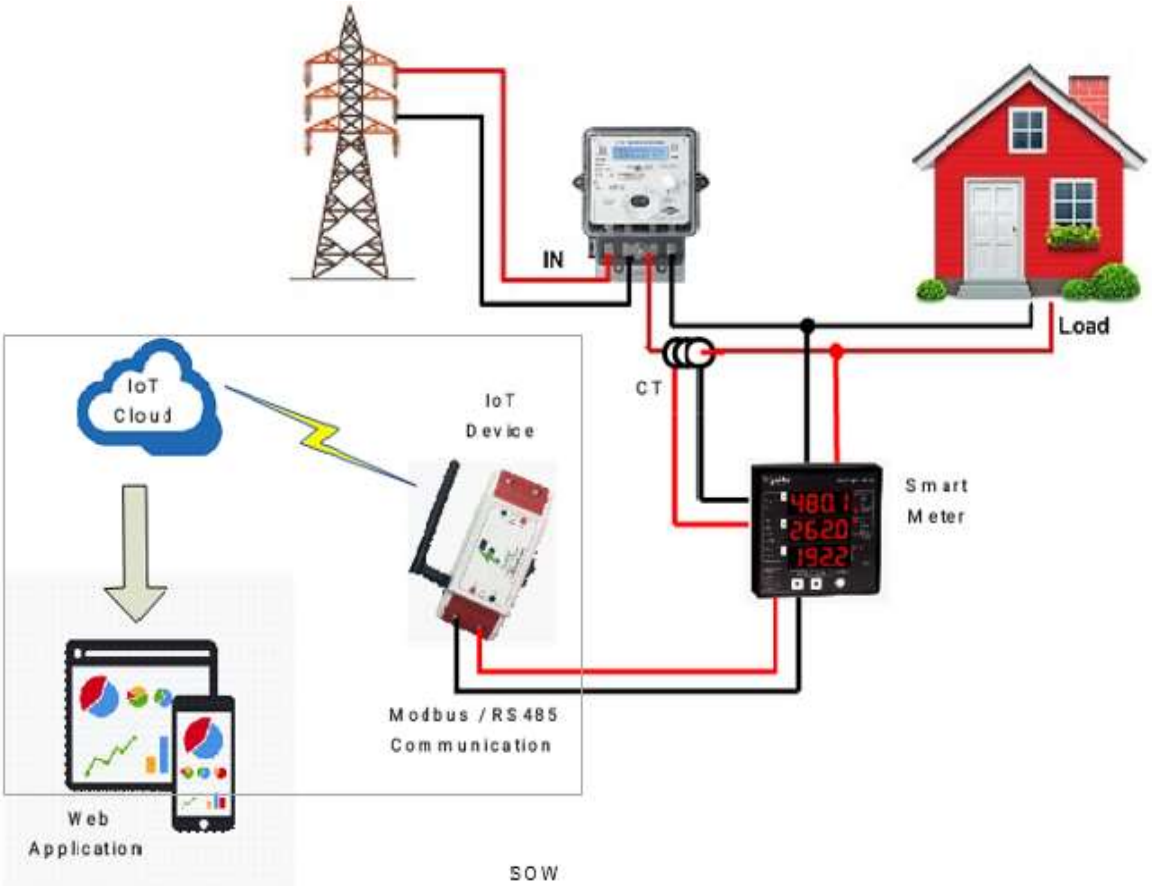

Fig. 3.5.1.1: - ARCHITECTURE OF EMS

The EMSA is an energy monitoring system with an original architecture. With the increasing use of distributed energy sources such as photovoltaic power generation, cogeneration systems, and storage batteries, this system can be used to control different resources and reduce electricity costs. The EMSA enables an aggregator, such as an electric power service provider, to build a system that bundles demand and to collectively manage energy resources and adjust power supply with demand response, thereby obtaining economic benefits.

Product features: -

- As it can be used with any type of equipment, this system can swiftly and wisely control different types of energy sources such as renewable energy systems, generators, or storage batteries without the need for manpower.
- Based on actual past data, the system is able to predict electric power demand, draft a plan for optimal operation of each equipment unit, and provide control in real time.
- With Open ADR 2.0, the system is able to provide a fully automated demand response.

3.3.2 FLOWCHART OF SYSTEM: -

A flowchart is a type of diagram that represents an algorithm, workflow or process. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows. Flowcharts are used in analyzing, designing, documenting or managing a process or program in fields.

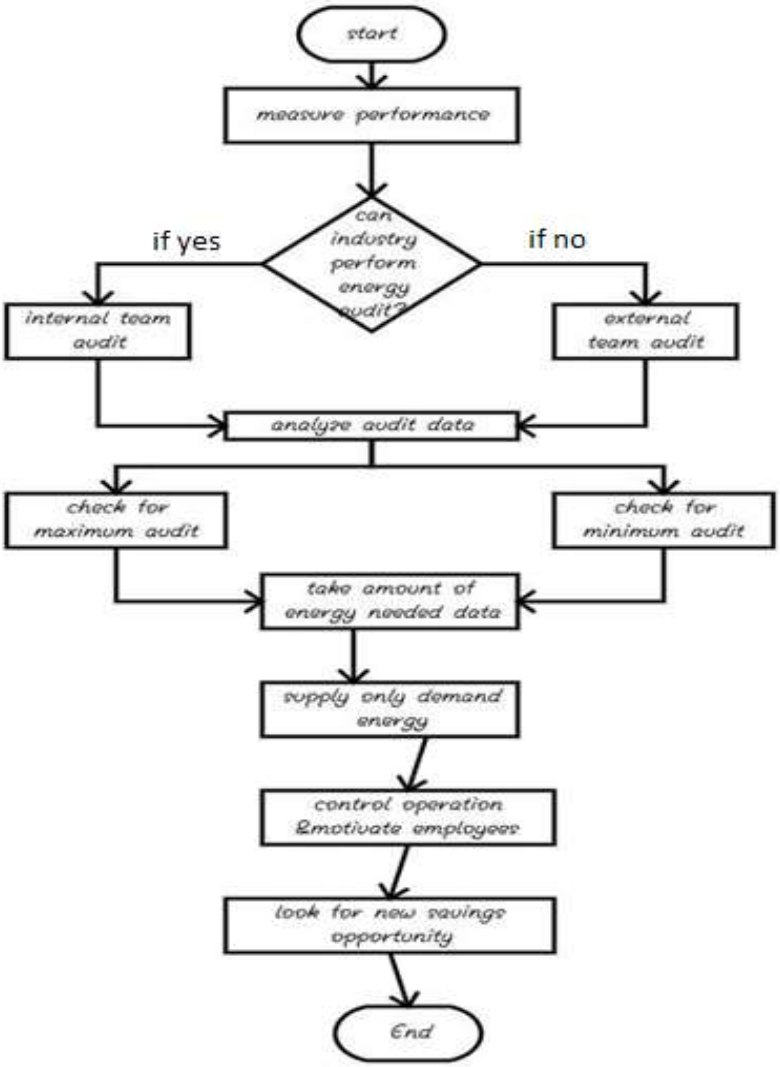

Fig. 3.4.1.1: - Flow chart of system

Each flow chart is concerned with one particular process or system. It begins with the input of data or materials into the system and traces all the procedures needed to convert the input into its final output form. Specialized flow chart symbols show the processes that take place, the actions that are performed in each step, and the relationship between various steps.

3.3.3 DATA FLOW DIAGRAM

A data-flow diagram (DFD) is a way of representing a flow of a data of a process or a system. The DFD also provides information about the outputs and inputs of each entity and the process itself.

Fig 3.1.1.1: Level 0 Data Flow Diagram

In DFD Level 0, Arduino IDE is microcontroller used to establish the connection and energy monitoring device is used to send the data to the serve

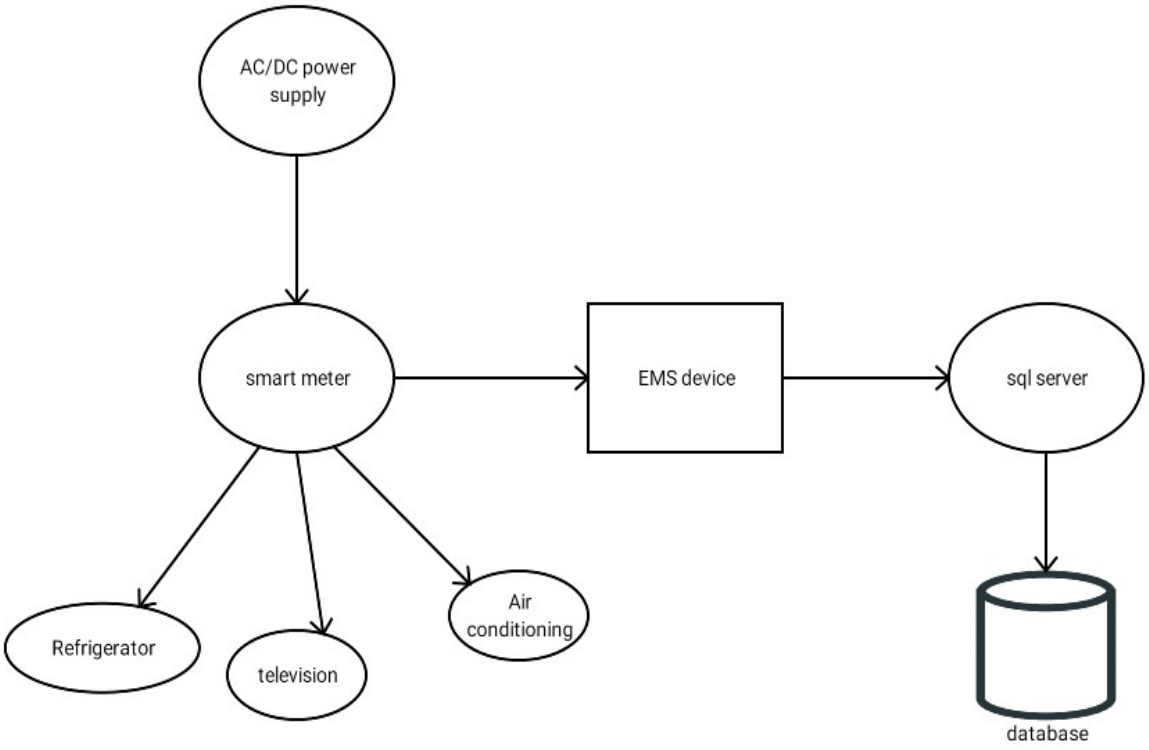

Fig. 3.1.1.2 Level 1 Data flow diagram

In DFD Level 1 Arduino IDE is connected via smart meter to the various loads. the smart meter gives the data to the EMS device. Then the device uploads data to server. Thus the data flow is shown.

3.3.4 USE CASE DIAGRAM: -

A Use case diagram at its simplest is a representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. This type of diagram is typically used in conjunction with the textual use case and will often be accompanied by other types of diagrams as well.

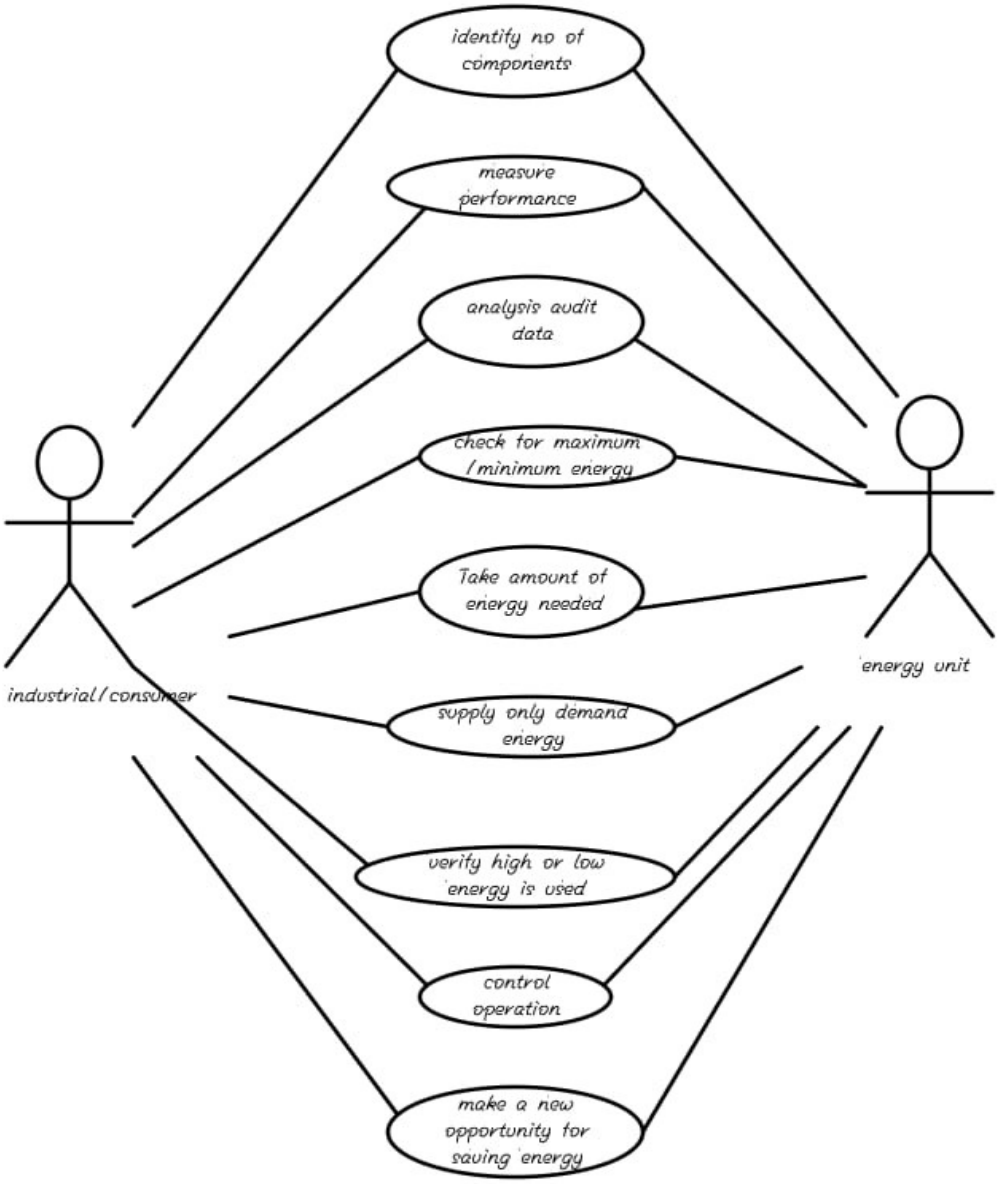

Fig. 3.3.4.1: - use case diagram of system

3.3.5 HARDWARE REQUIREMENTS: -

Followings are the hardware which are used in this energy monitoring system

- SIM 800 GSM Modem
- Microcontroller AtMega328P
- Modbus-2-RS232 convertor
- SMPS

SIM 800 GSM Modem: -

SIM800C is a quad-band GSM/GPRS module that works on frequencies GSM850MHz,EGSM900MHz,DCS1800MHz and PCS1900MHz.SIM800C features GPRS multi-slot class10/class12 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.SKU: WLC-0022Category: Wireless Tags: gsm, sim800, sim800 gsm.

Microcontroller AtMega328P: -

The high-performance Microchip Pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

Modbus-2-RS232 convertor: -

The key to understanding RS232 (and RS485) is that they are electrical standards. They have nothing to do with what bits are on the wire. A microprocessor has bits to send out: A Modbus Read Holding Register command for example. Those bits are emitted by a processor out of some pin at processor voltage levels. The processor is designed to interface to other integrated circuits (ICs) so it only emits a very small amount of current. Just enough current to drive an input port in some other IC. It does not have the voltage or current to drive a signal over even a few inches of wire.

SMPS: -

SMPS stands for Switch-Mode-Power-Supply. They are used in many places in a computer. In a modern computer, there is a SMPS that takes rectified AC input from the wall, performs power factor correction and then converts the output into one or more lower voltage DC outputs. SMPS stands for switch-mode power supply. Its job is to convert wall-voltage AC power to lower voltage DC power. Most computer chips in modern computers require power in the general neighborhood of 1.2-3.3V, with some older devices requiring between 5-12V DC. [5]

3.3.6 SOFTWARE REQUIREMENTS

Followings are the software which are used in this energy monitoring system

- Embedded 'C' or hardware coding: Arduino IDE Software
- Web Page Design: HTML, JS, CSS,
- Web App Development: ASP.net
- Database: MS SQL Server

Arduino IDE Software: -

The Arduino integrated development environment IDE is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.[6]

3.4 SYSTEM DESIGN: -

System design is the process of designing the elements of a system such as the architecture, modules and components, the different interfaces of those components and the data that goes through that system. The purpose of the System Design process is to provide sufficient detailed data and information about the system and its system elements to enable the implementation consistent with architectural entities as defined in models and views of the system architecture.

3.4.1 CLASS DIAGRAM

Class diagram is the main building block of the object oriented modelling. In this class diagram there are five classes known as load, smart meter, EMS device, database, user. The load will have attributes as voltage and power consumption and operation as consumer's power. The smart meter will have attributes as device number and operation as display readings. The EMS device will have attributes as device number and operation as takes reading. the database will have attribute as database name and operation as store readings. The user will have attributes as user name and operation as analyze power consumption.

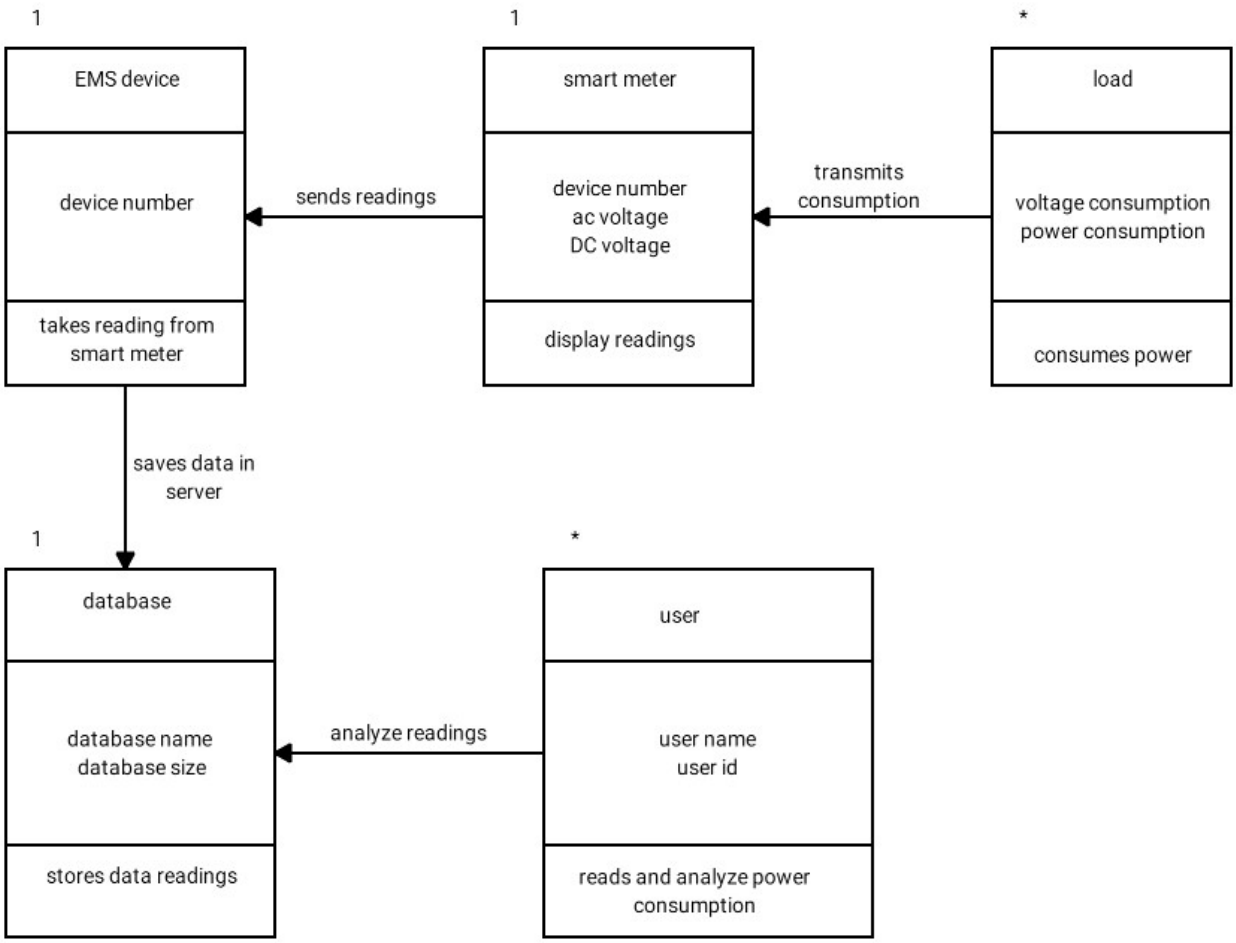

Fig 3.4.1.1 Class Diagram

3.4.2 COMPONENT DIAGRAM

A Component diagram comprises of the organization of physical components used in the specific system. In this system the components used are smart meter, EMS device and database. In the database the readings taken by the smart meter are saved to maintain the records.

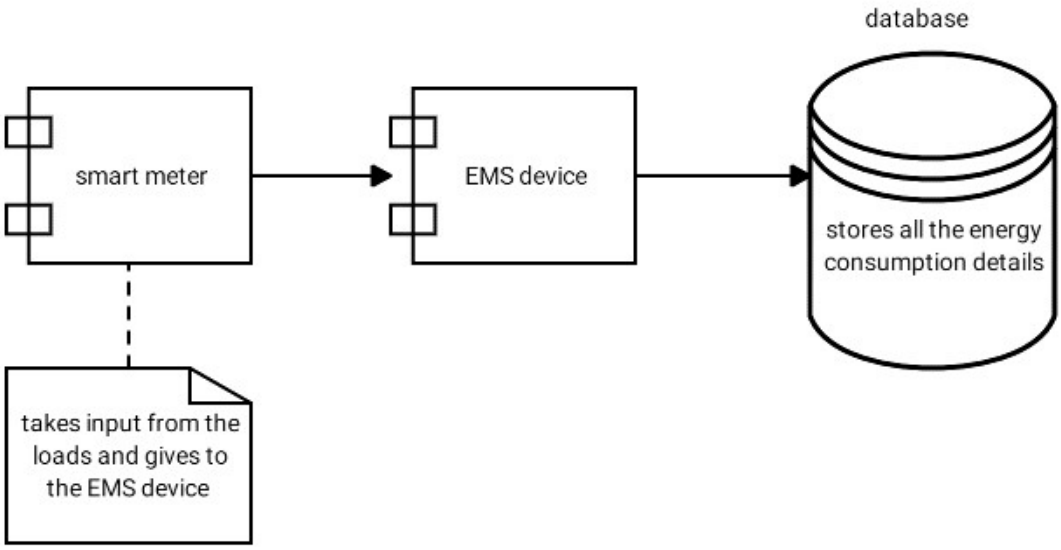

Fig 3.4.2.1 Component Diagram

3.4.3 INTEGRATION/DEPLOYMENT DIAGRAM

A Deployment diagram is UML diagram type that shows the execution architecture of a system, including nodes such as hardware or software execution environment and the middleware connecting them. In this diagram the nodes used are client, EMS device and server the Client has interface to the system by webpage or application. Then it goes to the EMS device the device then collects the consumption readings and transfers the data to the server.

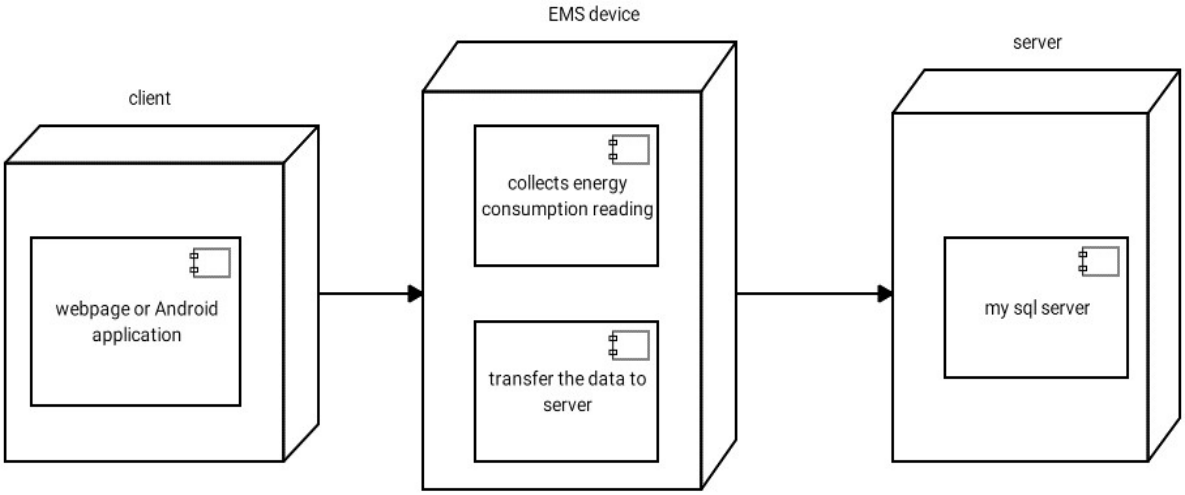

Fig 3.4.3.1 Deployment Diagram

3.4.4 USER STORIES

As a technical support manager

- I want the system to be able to get the suggestion own its own that where to make changes.
- I want to be able to get the power or energy consumption exact readings that means the readings should be error free.
- I want to be able to have the system working fluently and efficiently. The customer should be able to access the system remotely.

As a customer

- I want to able to access the system remotely that means I can access the system form any part of the country.
- I want the system to provide the actual readings without any error to make changes in the system effectively.
- I want the system itself to consume least energy as possible so that it should have very less effect on the electricity cost.

4. IMPLEMENTATION AND CODING

4.1 SYSTEM RELEASE PLAN

System Release Management is a process that entails the management, planning, scheduling, and controlling of an entire software build through every stage and environment involved, including testing and deploying software releases. In recent years, much has been said about process improvement and automation—and how these approaches help laboratories improve efficiency and cut costs. But equally important is their ability to reduce the opportunity for medical errors and increase patient safety.

SPRINTS	Task No.	Details	Expected Release Date	Remark & Signed By Project Guide/ Industry Mentor
SPRINT 0	1.	Hardware Setup		
	2.	Software Setup		
SPRINT 1	3.	Connection Establish between ems device and Database		
	4.	Current, voltage are taken as input		
	5.	Update the Input readings		
SPRINT 2	6.	Build web pages for the website		
	7.	Select a database for storage		
	8.	Connect the database to the website		
	9.	Check the connection of database To the website		
SPRINT 3	10.	Forward the readings to website		
	11.	Live readings shown in website		

	12.	Database save the data		
SPRINT 4	13.	Finally connect the Hardware and Software Module		
	14.	Test weather connection is established		

4.2 IMPLEMENTATION METHODOLOGY

Fig.4.2.1 EMS Unit

Fig.4.2.2 Smart meter

- Select the hard ware requirement I.e. Energy meter, Controller unit, GPRS module
- Design and assemble the circuit of EMS device
- Connect the device to the home appliance circuit
- Build a website for accessing the live readings and coding for having the graphs of readings
- Select a database server for storing the data such as MySQL
- Establish connection between database and website
- Finally connecting the EMS device and website together to start the whole unit

```
public partial class Default : System.Web.UI. Page

{

protected void Page_Load(object sender, EventArgs e)

{

con = New SqlConnection("Data Source=LAPTOP-D22FPRLH\SQLEXPRESS;Initial
Catalog=Darshan;Integrated Security=True;User ID=sa;Password=123456")
        con.Open()
{

SqlCommand com;

SqlDataReader dtr;

String s = "select top 1 * from EMS";

com = new SqlCommand(s, Con);

dtr = com.ExecuteReader();

if (dtr.Read())

{

lbl_nodeid. Text = data ["node id"] .ToString():

lbl_last_record.Text = dtr["trans datetime].ToString();

lbl_voltage. Text = dtr["vln"].ToString();

lbl_current.Text = dtr["a1"].ToString();

lbl_watt.Text = dtr["w1"].ToString();

lbl_pf.Text = dtr["pf"].ToString();

lbl_ frequency. Text = dtr["freq"]. Tostring();
```

```
lbl_wh.Text = dtr["wh"].ToString();

}

}
```

}

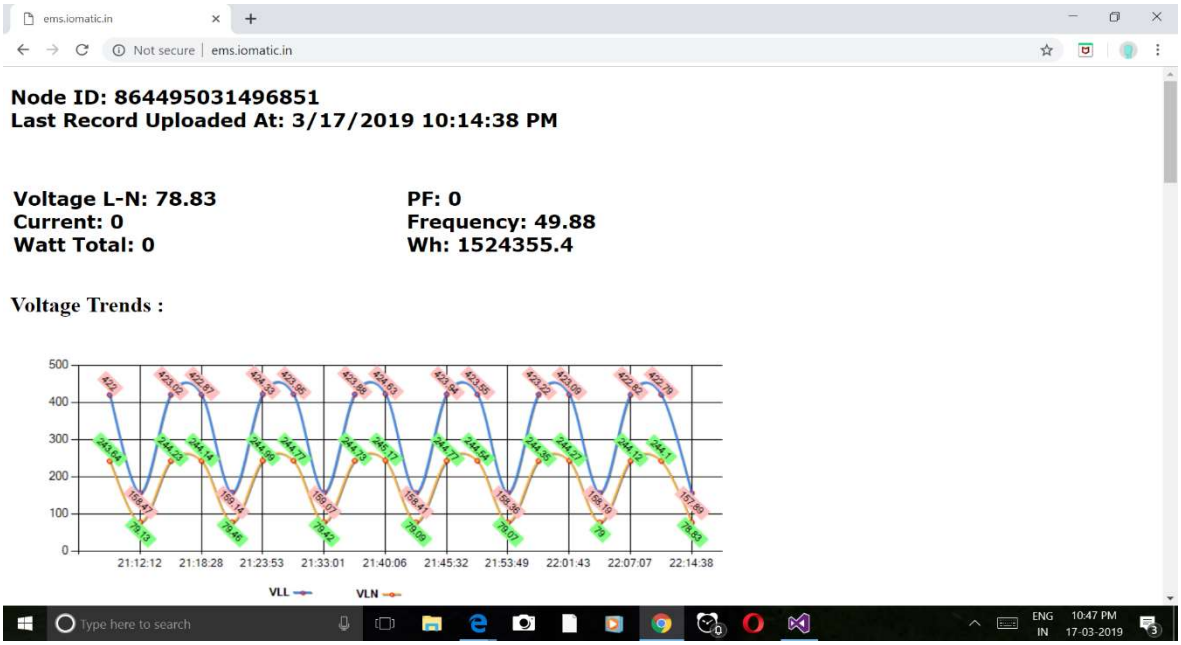

Fig 4.2.3.Voltage graph

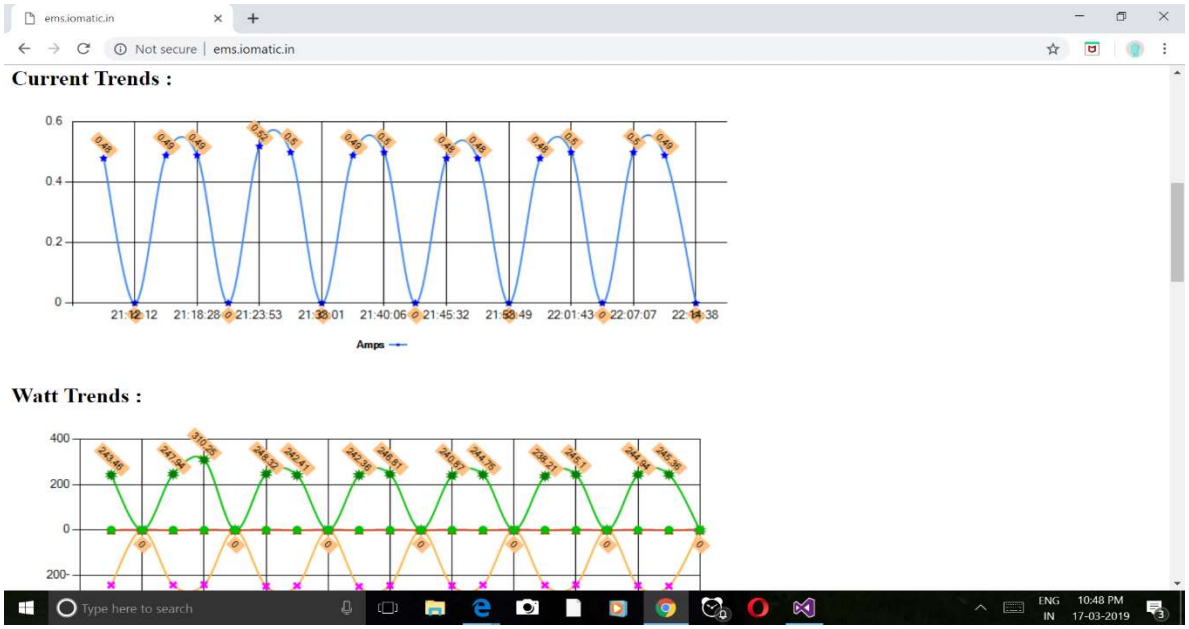

Fig 4.2.4.Current and Watt graph

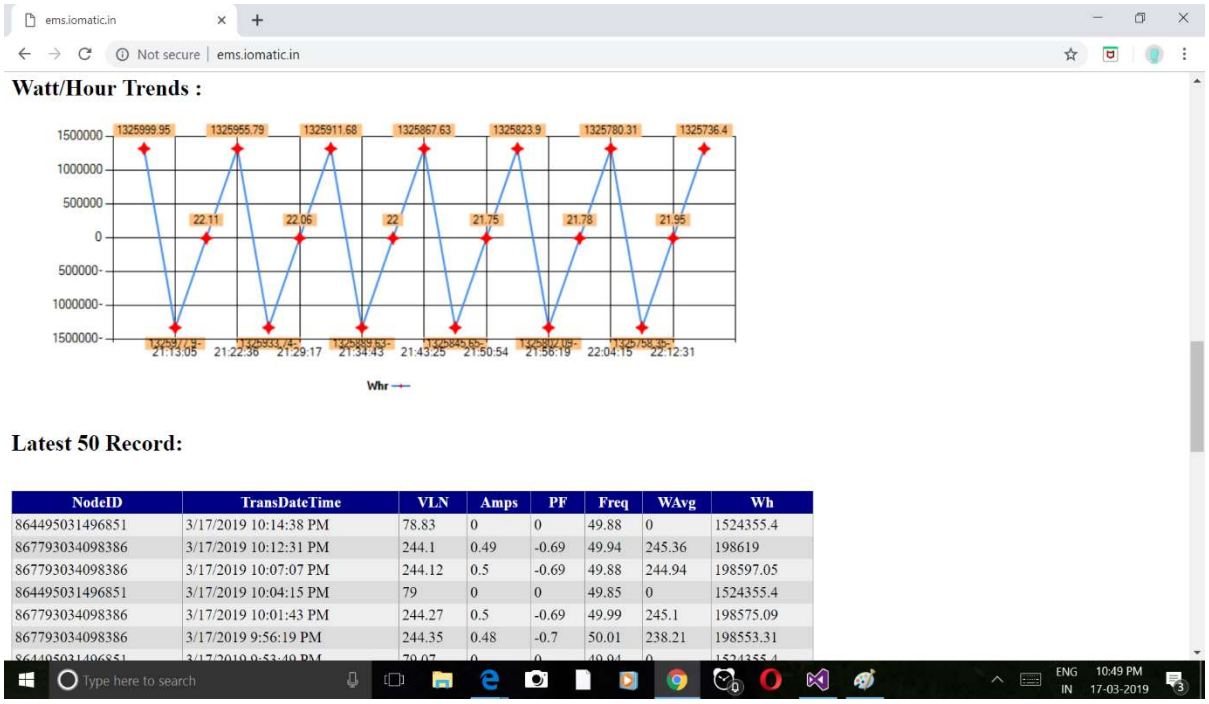

Fig 4.2.5.Watt/hr graph

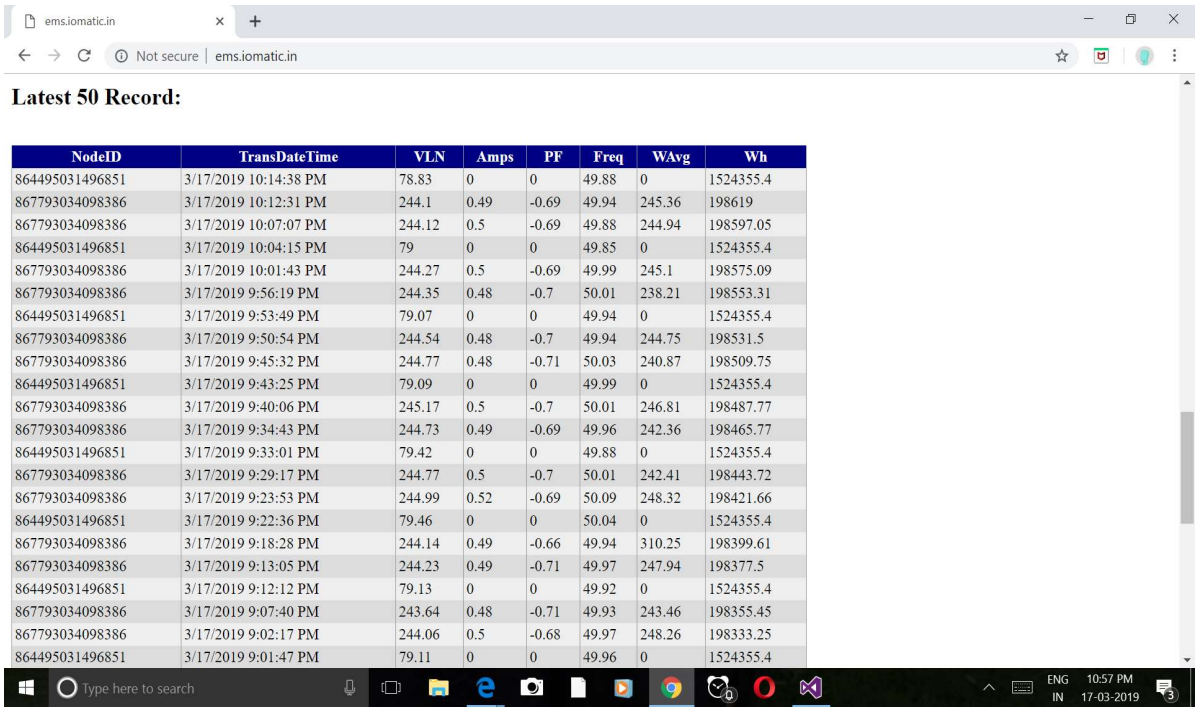

Fig 4.2.5.Latest Record

5. TESTING

5.1 TEST CASES

Test cases to be automated can be selected using the following criterion to increase the automation ROI

- High Risk - Business Critical test cases
- Test cases that are repeatedly executed
- Test Cases that are very tedious or difficult to perform manually
- Test Cases which are time-consuming

Sr. No.	Test Cases	Result (Pass/Fail)	Remark (If Fail)
1.	Establish Connection	Pass	
2.	Smart Meter Showing Readings	Pass	
3.	Website accessible	Pass	
4.	Live readings are showing on website	Pass	
5.	Database saving readings	Pass	
6.	Database being updated	Pass	
7.	Showing graphs of readings	Pass	
8.	Is the system remotely accessible	Pass	

5.2 FUNCTIONALITY TESTING

Functional testing refers to that kind of testing which checks whether each and every component of your product is working or not. Functions (or features) are tested by feeding them input and examining the output. Functional testing ensures that the requirements are properly satisfied by the application.

FUNCTIONAL AUTOMATION TESTING:

The purpose of functional testing is to ensure that the application and all of its individual functions work as they should in the real world and meet all requirements and specifications, whenever

any changes done in any functionality of project it would require to test that particular functionality along with dependent functionality as well in terms of manual testing it will take very much time to test whole system. To minimize the time and perform regression testing again and again test automation will come into the picture. Test automation further helps us to automate test cases and features that are constantly regressing.

This way QA's have more time in testing other parts of the application. Moreover, this helps in ensuring the quality of the product in application releases. As a result, we get products that are more effectively and stable, and its help to streamline QA process. Through automation testing, it will help to lower the cost of bug fixing and also help us to improve the quality of application as well as process. Objective of functional testing to cover application system and mainly focus on main functions, basic usability, accessibility and error conditions.

5.3 UNIT TESTING

Unit Tests are conducted by developers and test the unit of code (aka module, component) he or she developed. It is a testing method by which individual units of source code are tested to determine if they are ready to use. It helps to reduce the cost of bug fixes since the bugs are identified during the early phases of the development lifecycle.

Unit testing is commonly automated but may still be performed manually. Software Engineering does not favor one over the other but automation is preferred. A manual approach to unit testing may employ a step-by-step instructional document.

5.4 INTEGRATION TESTING

Integration testing is executed by testers and tests integration between software modules. It is a software testing technique where individual units of a program are combined and tested as a group. Test stubs and test drivers are used to assist in Integration Testing. Integration test is performed in two ways, they are a bottom-up method and the top-down method.

It's a systematic technique for constructing the program structure while conducting tests to uncover errors associated with interfacing. All modules are integrated in advance, and the entire program is tested as a whole. But during this process, a set of errors is likely to be encountered.

6. CONCLUSION AND FUTURE SCOPE

The main aim of the project is to design and construct the Energy Monitoring system that can be remotely operated to monitor different loads. This system will allow the user to get the live status of the loads connected to a particular system and which can be monitored remotely from any place

The EMS system is implemented on small scale in different companies and industries to reduce the excess use of energy. by which the industries are able to reduce the cost of energy which is surplus. thus it has played vital role in excess cost reduction.

This system has to be modified and made fully automated so the system can analyze the readings on its own .so if it is made fully automated with the help of IOT then it will have a great success. so in future it can be made more efficient and it will be beneficial in all fields due to its more advance functioning. As we will be able to remotely monitor as well as the system can be able to do the changes on its own.

7. REFERENCES

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ANNEXURE I

1. Stakeholders Details

Project Title: Energy Monitoring System

Project Type: Industry Based

Stakeholders:

Sr No.	Stakeholders	Name	Designation, Company name	Contact No.	Email Id
1	Industry Mentor	Mr.Nilesh Sahare	Developer, Trainer, Blogger	9970575791	connect@anvinfotech.com
2	Alumni Mentor	Ms.Manali Thakre	Trainer	9766261305	Manalithakre125@gmail.com
3	Project Guide	Prof.Hemlata Sahu	Assistant Professor	8087101546	hema.sahu88@gmail.com

2. Project Members Details

Sr No.	Name	Contact No.	Email Id	Role	Github Account Details
1	Darshan Dhone	9518526876	darshandhone98@gmail.com	Team Leader	None
2	Pawan Ukey	8999108657	pawanukey12@gmail.com	Programmer	None
3	Tarun Pathe	8788052455	tarunpathe1@gmail.com	Developer	None