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IoT Based Design and Implementation of Intelligent Energy Distribution Management with Photovoltaic System

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Abstract: ***The grid operators have difficulties as a result of the increasing penetration of renewable sources due to reduced environmental contamination. Unrestrained energy use will undoubtedly deepen environmental harm and accelerate global warming. A best practice for effectively managing energy use is energy management. IoT technology can be leveraged by technological advancements to facilitate energy management. This paper offers a novel way to energy management using a solar system and the Internet of Things (IoT). The suggested system tracks, evaluates, and optimizes solar power use in real time with the goal of increasing energy distribution's intelligence and efficiency. The project's goal is to build a net energy meter (NEM), a unique billing system that gives solar PV system owners credit for the entire retail value of the electricity their system produces. Under NEM, a customer's electric meter tracks how much energy they use as well as how much extra energy the system produces and feeds back into the electric utility grid.***

Keywords: Energy meter, Optocoupler, LCD display, ESP8266 WIFI module, Micro controller, Crystal oscillator, LED indicator.

I. INTRODUCTION

A variety of power plants and other sources of electricity that may provide power continuously are referred to as "renewable energy." The sun, rain, tides, tidal pools, biomass, and geothermal sources can all be used to generate energy. Fully self-sufficient power generation systems composed of renewable resources have been developed as a result of increased use of renewable energy sources [1]. Everywhere a guy lives or works, power is a major factor. A country's wealth and style of living strongly correlate with the amount of power used. The world energy report states that traditional fossil fuels like oil account for roughly 80% of our energy, coal (23%) and natural gas (21%). It is commonly understood that there won't be much longer until all of these resources are used up [2]. Therefore, in order to prevent an energy crisis in the near future, alternate sources should be used. The finest source of sustainable energy is solar energy. The customer gives this electricity to the utility. This amount of electricity will be billed by the Microcontroller with the help of Energy Meter Reading. At the end the micro controller will show the total net amount to be paid by the end user also the power which is exported to the utility will be detected from the net amount. The net amount is displayed on LCD. Microcontroller will display the KWH readings into the Thingspeak cloud along with date and time using ESP8266 WI-FI module. An Internet of Things system comprises of both software as well as hardware, that includes both physical and digital components. There has been an obvious rise in interest in the Internet of Things during the last several years [3]. The construction design was created in a way such that it allows end users to access the online data storage obtained by power plants via internet at free cost or for a little price. The writers designed the solar monitoring system which is affordable to the end user with the help of internet of things in various ways, it is possible to use this system as a case study to show how to manage multiple types of electrical current. An ISEMS (Intelligent Smart Energy Management Systems) system [4] that would be used for end user -side energy management and would take source of sustainable energy into consideration was suggested to be built in the paper. This was done so that the system could be utilized for energy conservation.

The Internet of Things promise in managing hybrid power grids [5] was panned by the authors studies. Considering numerous sources of sustainable energy, such as solar, biofuel, fuel cells, and other mixed forms of sources of sustainable energy, is one of the numerous strategies that might be used for offering a more reliable source of power. It illustrates that these various types of sources of sustainable energy sources which also consist of solar power. The alternative methods consist of the following: hybrid energy system require energy management, irrespective of all the weather conditions they are used in household or commercial settings.

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We can also say that it is also utilized in industrial settings. Consequently, by this we can understand that the internet of things is having an important influence on both the quantity of power which is used and the distribution of power.

II. LITERATURE REVIEW

Many scholars have discussed Energy Management and its implementation frameworks in the last few years. In this section, the critical points of some of the latest researches are discussed. The edge server contains code blocks for the IoT platform and alleviates its minimal memory power by loading the IoT device blocks. Moreover, the IoT system can extract electricity from environmental sources in order to accomplish a sustainable process.

Krishnamoorthy et al. Proposed an IoT method that tracks load power usage and effectively saved electricity [6]. IoT could be used for various purposes, from home automation to sectors where real things are connected to a network from Everywhere in the year 2020.

Dr. Rajesh Gupta has worked on energy-efficient computing and smart grid technologies [7], which may include aspects related to intelligent energy distribution management between the year (2013-2016).

Dr. Vijay Gupta has expertise in control systems [8] and has likely contributed to research on intelligent energy distribution systems, including those incorporating photovoltaic systems in the year 2022

Bedi, Guneet, et al., Created Elman's recurring neural network model and an exponential electrical power prediction model in a building environment powered by IoT [9]. The models forecast the usage of electrical energy by an electrical load in which a relationship occurs between the net consumption of energy by the electrical loads in the building and the atmospheric temperature and the building's occupancy; and in which electrical energy consumption is predicted using the forecast temperature and schedule in the year 2020. Lasso-Lopez et al. Presented the development and deployment of an IoT prototype for energy monitoring [10], established by a group of undergraduates studying the challenge-based learning paradigm to strengthen their disciplinary and interdisciplinary competence in the year 2019

Almonacid-Olleros, et al., There have been multiple machine learning models tested to determine a photovoltaic (PV) system's behaviour and energy efficiency [11]. The author also utilized several types of estimates for power to test computational models of solar panel systems between the year (2012-2016). Avancini, Danielly BRodrigues, et al., [12] Built and actual verified a low-cost smart meter solution for internet-based energy monitoring. It forwards the data collected by smartphones via Wi-Fi and collects them using an IoT middleware equipped with energy management ability in the year 2020. Han, Tao Muhammad, et al., [13] Concentrated on the needs of today's smart grids, homes, and businesses to build a deep, intelligent learning system for energy management. Yu, Qingguang Jiang [13], Design and implementation of the IoT control strategy in smart microgrid based on the NEZB were proposed. The framework of the intelligent supervisory control and data acquisition (SCADA) system was planned for the online control of energy usage and climate parameters between the year (2020-2022).

The wide penetration of renewable sources such as photovoltaics (PV) and tidal unit (TU) which have changed the passive distribution systems into active systems. (Dabbaghjamanesh, Wang, Kavousi-Fard, Mehraeen & Hatziargyriou, 2020).

III. EXISTING SYSTEM

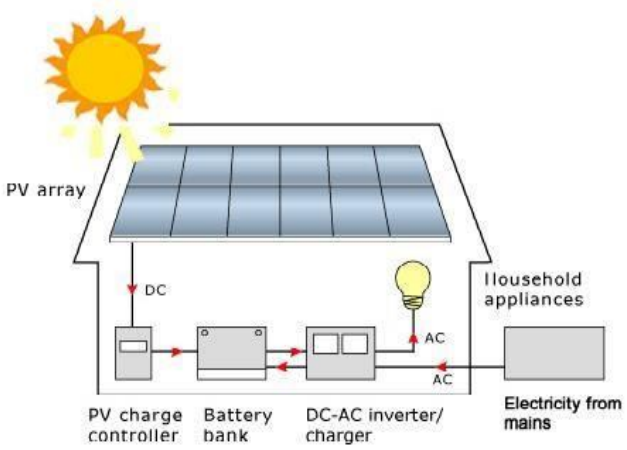


Figure.1: Structure of General Photovoltaic System

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Systems that use renewable energy, including fuel cells and photovoltaic power generation, are receiving a huge attention globally. Eco-friendly power generation is the best feature of renewable energy systems [14]. Sources of sustainable energy do not produce any sort of pollution into the air at the time of generation of electricity. However, most power plants such as thermal power generation and nuclear power generation plants have produced most of the power supply [5]. Thermal power plants emit the carbon dioxide into the atmosphere, and nuclear power plants have potential danger and discharge nuclear wastes. On the other hand, renewable energy systems are very clean. Although renewable energy power generation unit cost is more expensive than fossil fuel generation, this type of generation will replace the existing power plants because it is an inexhaustible resource. Consequently, we can say that it is the main resolution to clear the different sorts of energy problems.

IV. PROPOSED SYSTEM

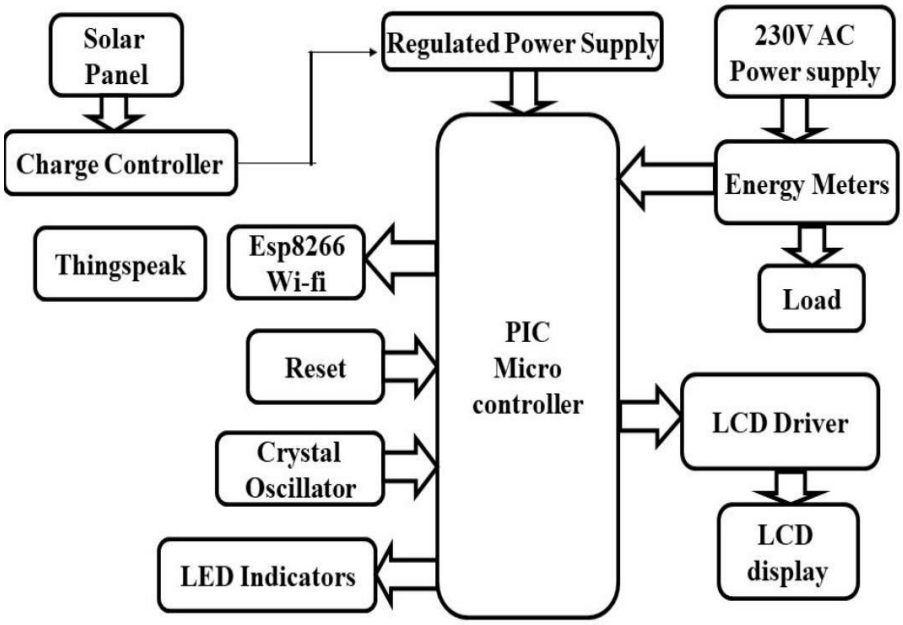


Figure.2: Block diagram of proposed system

The shifting patterns of energy consumption and generation poses issues for conventional energy distribution networks. Automated systems which can easily combine conventional energy sources especially photovoltaics into the current energy infrastructure is of vital importance as these sources grow to raise in prominence. By considering IoT abilities, the proposed system aims at solving issues by creating an intelligent and flexible energy management solution. This project's main goal is to create and put into place an intelligent energy distribution management system that balances energy production [5], consumption, and storage in the best possible way. The addition of a photovoltaic system improves the sustainability even more utilizing solar energy as a solution to fulfill the changing demands of a contemporary, environmentally concerned society.

The main components used in proposed system are: Energy Meter, LCD display, PIC Microcontroller, ESP8266 WI-FI Module, Crystal Oscillator, reset button, LED indicator, Sensors and IoT Devices.

The system is easy to use and inexpensive also enables people to get real value for the energy they produce, without having to install a second meter or an expensive battery storage system. The system allows home owners and businesses to produce energy, which takes some of the pressure off the grid, especially during periods of peak consumption [8]. Every household can possibly provide power for more than three user's home. If enough, homes in a neighbourhood use renewable energy and net metering, the neighbourhood could potentially become self-reliant. This will motivate users to serve a vital role in renewable energy generation, which will provide us electricity, save the earth as well as protect the use of renewable energy sources. The households who are using net metering system can be more alert, and conscious about the usage of energy. electricity companies can save the expense on installing meter, power reading and invoice meters. Using IOT Thingspeak technology. KWH readings will display on LCD.

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V. METHODOLOGY

The reset button tells us about the mechanism of both software and hardware which will allow us to replenish the equipment to its initial state at an instance of failure or halt. The PIC microcontroller can potentially be together to a crystal oscillator which having a frequency range of DC to 20 MHz. Power supply is a supply of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU [15]. The power distribution systems and primary or secondary sources, which includes the conversion of electrical power from one source to the required form and the voltage usually shifting AC line voltage into a well-regulated lower voltage DC power supply units with a small voltage and little power are frequently come with electronics they also provide, namely computers and domestic appliances.

A semiconductor device is known as a light-emitting diode (LED) releases light when electricity passes through it. To generate white light, either a light-emitting phosphor layer or several semiconductors are used in addition to the semiconductor device.

Electricity meter is a device that measures the amount of electricity consumed by an apartment, company or electrical device. Energy meters are usually calibrated in billing units, the most common of which is kilowatt-hours [5].

An optocoupler is the protective device. It is an isolated power supply can be frequently the most sensible and safest option. Here's the basic on today's LED/photo detector isolators and what you need to know to apply them to your system [3]. The LCD display is among the most often linked devices to a micro controller. Several popular LCD panels that are often linked to numerous microcontrollers [4] include the 16x2 and 20x2 models exhibits. This translates to 16 and 20 characters, respectively, per line by two lines. A SOC microchip primarily utilized for the creation of end-point Internet of Things applications is the ESP8266 Wi-Fi module [8]. We call it an independent wireless transceiver, which is reasonably priced. It is utilized to make the internet connection possible for a variety of embedded system applications. Computer systems intended to carry out one or more specialized tasks, frequently with real-time computing constraints, are referred to as embedded system [3].

VI. APPROACHES

Thingspeak [5] is a platform providing various services exclusively targeted for building IoT applications. It will provide us the ability to collect the real-time data, and the data which is collected can be shown in the form of charts, the capacity to develop apps and extensions for interacting with online services, interpersonal network and other APIs. Below, we will go over each of these outputs in more depth. Creating the Thingspeak channel is the main part. The channel is used to save the data so that it can send to Thingspeak and consist of the elements shown below:

1) Eight fields for storing any sort of data can be used to store information from embedded devices or sensors.
2) Three location fields: These can be used to record elevation, longitude, and latitude. These are excellent for following an object that is moving.
3) 1 status field - we get a short message to explain the data saved in the channel.

We have to sign up and create a new channel to utilize the application called Thingspeak. when we create the channel, then we are able to send the data, we can access Thingspeak to process it and also continue the same. we can start using Thingspeak by signing up and setting up a channel.

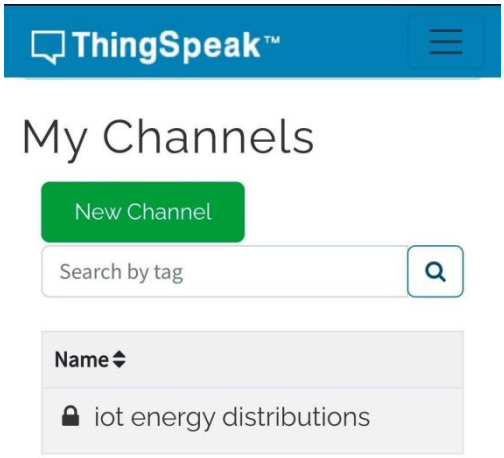


Figure.3: Thingspeak interface

VII. OUTPUT

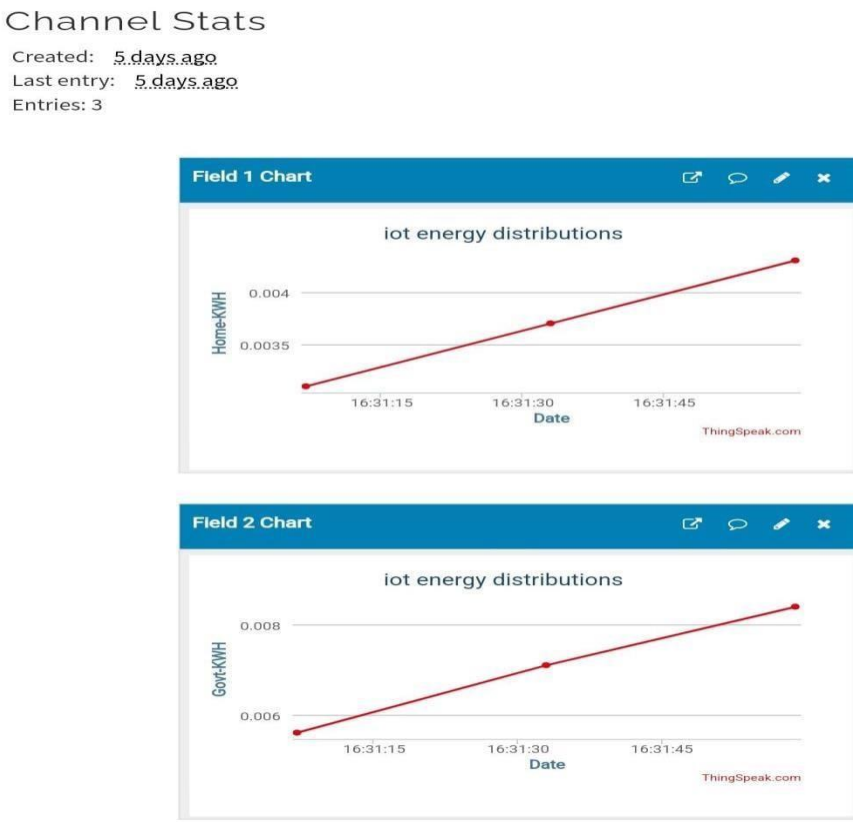


Figure.4: Thingspeak channel status

VIII. CONCLUSION

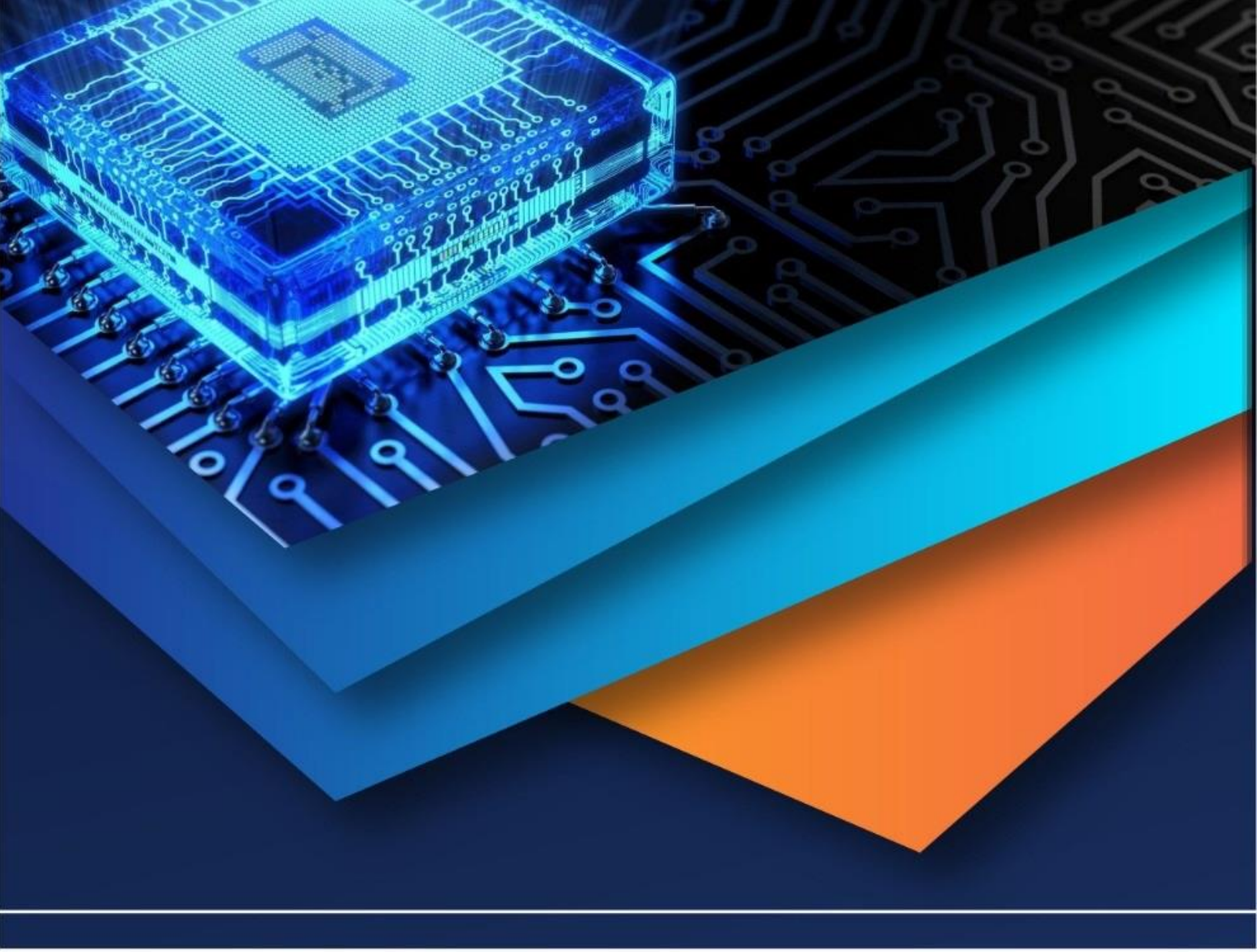
It has been built with features that combine all of the hardware components that are used. Each module's functionality has been thoughtfully considered and arranged to enhance the unit's functionality. Secondly, using highly advanced ICs with the help of growing technology, the project has been successfully implemented [10]. Therefore, the system has been designed and tested successfully. By extracting sustainable energy, the system can actively save the environment. Also reduces the usage of carbon emission and reduces the effect of climate changes.

The Internet of Things system's [8] modular architecture enables smooth expansion to handle changes in energy demand or the addition of new devices. Because of its scalability, the system can adapt to changing needs in the future. The ability of cutting-edge technology to transform the field of energy management is demonstrated by the IoT-based intelligent energy distribution management system [13] with a solar system. The achievement of this highlights the significance of continuous innovation, flexibility, and a dedication to sustainable methods in addressing the forthcoming energy obstacles. The knowledge gained from this study will surely guide and inspire future developments in the field of intelligent and sustainable energy solutions.

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