IOT Based Solar Energy Monitoring and Smart Metering

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***Abstract*—**The Internet of Things has a vision of the internet permeating every aspect of our daily lives, with internet-enabled items playing a prominent role. The IoT makes it possible for things to be sensed or controlled remotely, using existing network infrastructure, resulting in increased efficiency, accuracy, and economic gain in addition to decreased human involvement. Daily use of renewable energy is tracked via Smart Monitoring and it also helps in detecting power theft with the use of IoT and good step towards digital India. Thus, to analyze and control power consumption, use of IoT plays an important role. This makes it easier for the user to understand how much energy they are using. Renewable energy use and power problems are both affected by analysis and the proposed smart Energy Meter uses Internet of Things (IoT) to automate remote data collection, human Intervention and save time. The work also involves cellular connectivity to provide secure measurement of reading from the meter to the controller.

This project suggests a few steps to stop electricity thefts, such as meter tampering, meter bypassing, and meter removal. As This time period was the most successful in history for renewable energy, with the growth rate being much higher than before. The method mentioned here talks about displaying the energy consumption of solar power on the internet as a renewable energy.

Keywords: Power Theft; Prepaid; ESP32; Relay; Easy Bill Calculation ; Display Of Readings In The Web Page.

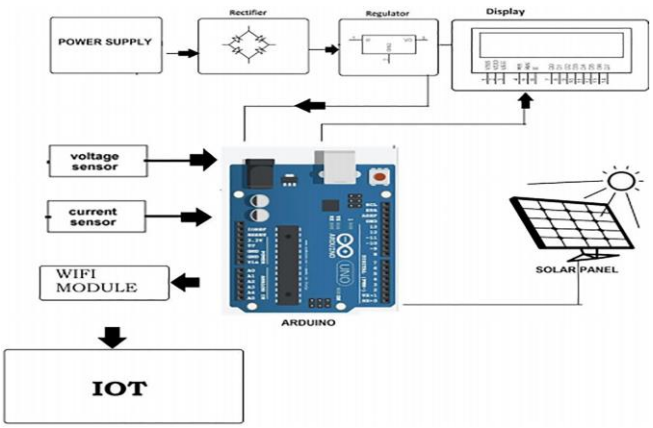
I. INTRODUCTION

The project's objectives were to lower energy loss, increase grid effectiveness, and promote the use of renewable energy sources. One of the most significant technologies of our daily lives is the Internet of Things (IoT). An IOT is a physical gadget used to let machines connect to the cloud. This connects linked devices for exchanging data Network is free. The user may get the info and interact with the gadgets via the internet. Anywhere on Earth there are web-enabled devices that make up this ecosystem. To collect and transmit the data by using CPUS, sensors, and other communication hardware components By IOT allows us to build up machine-to-machine (M2M) or device-to-device (D2D) connections without requiring human intervention. Computing resources and software systems are also used in the process. This solar power monitoring system's requirement for utilising IoT technology is due to the range of sunlight radiation. The current solar panel yield is not set and may fluctuate depending on location, time, and environmental circumstances. Exposed to the sun all the time, they must be constantly checked. You can monitor the solar panels from Using iot technology.

The fact that solar electricity is abundant, together with lower costs of the conversion technology, has made it extremely popular. Solar energy is the conversion of light energy into electrical energy, Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanoelectronics, Nanophotonics, Nanomaterials, Nanobioscience & Nanotechnology often known as photovoltaic effect. Due to the use of solar electricity, pollution will be decreased and energy forecasts, homes, and communities may all be improved in addition to this. The monitoring of this system allows us to know about the system's condition, as well as telling us when anything is wrong, which is quite useful. Conventional sources like as coal, natural gas, and fossil fuels may be put to use again while renewable resources are re-utilized. . Smart energy meters incorporation of IoT technology has made energy management more efficient and effective, which has reduced costs and improved the environment. The Internet of Things (IoT) is the idea of attaching common things to the internet, enabling them to send and receive data, converse with one another, and carry out numerous functions without the need for human interaction.

PROPOSED SYSTEM

A new IOT-based solar power monitoring system is described in the proposal. This system incorporates solar cells that turn sunlight into energy, which are installed in solar panels. We have an Arduino in our fleet. Using sensors, current voltage parameters are monitored. The current and voltage values are the same. Everything that's displayed on the LCD panel is shown here. Through which the sensors it is linked to, an IOT device is able to a parameter's display on the display is always accessible, so the user may track its value from wherever network



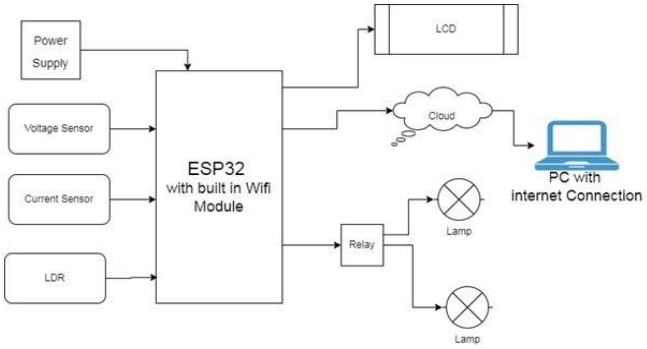


Fig. 1. Block diagram of proposed system

The newest advancement in the energy industry is smart energy meter built on the Internet of Things. These meter can measure, monitor, and regulate energy use since they have sensors and wireless communication capabilities. They allow consumers to remotely regulate their energy consumption in real-time and are internet-connected. This methodology installs a smart energy meter within the user's property, which counts the energy the user uses. The central server receives the data from the meter through a wireless network, processes it, and produces a report on the energy usage trend. The smart energy meter detects energy consumption in real-time, allowing users to keep track of their energy use and adjust their consumption habits as needed to cut down on energy waste. Users have the ability to set energy usage warnings on the meter, which alert them when their energy consumption limitations are going to be exceeded. The tamper-proof mechanism on the smart energy meter guards against any unauthorised access to the meter. Additionally, the meter features a backup battery to ensure that it can still function in the event of a power loss. A report of the energy usage pattern is produced by the central server once the data from the smart energy meter has been processed. The report provides information on energy usage, peak usage times, energy waste, and energysaving advice. Users can access the report via a web interface or a mobile application. Energy providers can keep track of their clients' energy consumption in real-time thanks to the smart energy meter. As a result, they are able to forecast energy demand and supply appropriately.

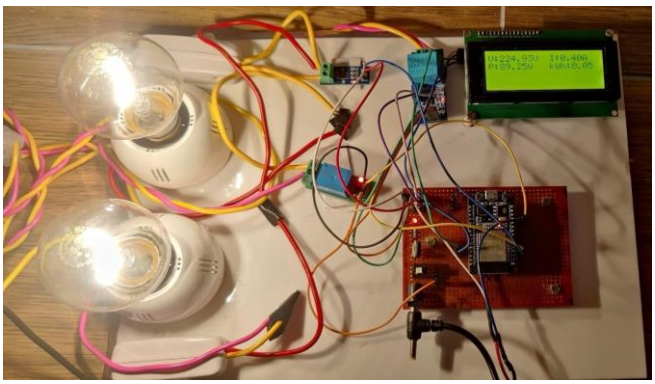
IoT is currently evolving as new gadgets and applications are always being created. There are worries about security, privacy, and the possibility of gadgets being hacked or used maliciously as the number of linked devices keeps increasing. However, many experts think that in the long run, the advantages of IoT will exceed the hazards and that this technology will become more and more crucial to our lives.

Our primary goal for this research is to get an optimal power output when dust buildup occurs on the solar panels. Another thing to be aware of is that if there is any problem with the solar panels, the system will no longer work. We have information regarding whether or not The loads may be linked to the grid using a solar or battery setup. Discovers and recognizes Ensures the system notify user or administrator when a fall below predefined criteria is detected, and then displays an alert on the GUI. To produce energy from the sun. This one constantly monitors the sunshine. In this video, various values such shown on the LCD is current, voltage, and temperature utilizing Internet of Things (IOT) technologies.

3. *HARDWARE IMPLEMENTATION OF THE PROPOSED METHOD*

A home solar power system's most noticeable feature is the solar panels. To create the P V solar cell, a thin-film semiconductor, or crystalline silicon, is used in applications. Photovoltaic (PV) gadgets use photovoltaic technology devices that convert sunlight straight into energy electrical gadgets are on and they are supplied, or it has been sent to the grid. Electrons are released in these materials when exposed to sun radiation. An example of Getting your solar panels to generate is key Maximum efficiency in the use of electrical energy is keeping them healthy and full direct sunlight DC voltage current is produced when the DC voltage is applied to the battery. Solar panels face the sun directly. The solar panels provide the direct current that is needed for the household appliance. In this way, the AC power gives us the output of the panels invertor. Appliances need the inverter to regulate all of their functions. A battery forms the basis of an invertor. Battery is charged when it is connected to a power source. An appliance is out of service and hence gets deactivated when it is required supply. Solar monitoring devices will record the quantity of solar energy that is produced. This solar power has helped produce the energy that your panels have contributed to high-voltage power grid We have utilized a light dependents resistor in order to sense the light the resistance changes according on the intensity of the light falling on the component It and can. These two words may change a night into a day. There are many possibilities possible monitoring methods for solar panels there are modern and technologically advanced solutions This automatically uploads data to a web portal that you can monitor You may monitor the functioning of your systems from anywhere across the globe. We have an opensource cloud running the software in our suggested solution. The platform application 'think' and 'speak' are all important. Which collects and organizes saves sensor data or linked device data hypertext transfer protocol-based internet systems Local network connection to the cloud. It always keeps everything up to date measurements provided by sensors, application trackers, and Status gives users to them, and it is obtained from the users. This is created for usage by users who have an account that includes various attributes systems where many characteristics are monitored the remote monitoring of the parameters. This cloud is user-friendly makes it possible for administrators or users to see the data visually illustration surveillance via the internet uses new technology Your solar panel's output data is sent to a router, so it may be made accessible to anywhere you have internet access. Main application of the node MCU is, which is built on a single board, utilizing the Arduino IDE, and including a RAM size of 128 KB and programmer storage capacity of 4 MB. It's powered by a USB cable and has an in-built Wi-Fi soc Architecture, and can be powered through a USB voltage of 3.3 to 5 V. A web interface systems like this have several advantages, especially when it comes to routine tasks. Smart energy meters incorporation of IoT technology has made energy management more efficient and effective, which has The smart energy meter's hardware design entails picking the right sensors, microcontroller, and communication module. The current and voltage sensors are used to measure the current and voltage levels of the electricity flowing through the meter, respectively. The LDR sensor is used to find any unauthorized

individuals tampering with the meter. The ESP32 is in charge of processing the sensor data and operating the communication module to send the data to the cloud server. Installation of sensors: The primary power supply line would be equipped with voltage and current sensors to track how much energy is being used. For the purpose of detecting any efforts to tamper with the meter by covering it with a cloth or a black bag, an LDR (Light Dependent Resistor) sensor would be positioned close to the meter. Processing and data collection: A microcontroller such as the ESP32 would be used to collect and process the sensor data. The microcontroller would be designed to read the sensor data and send it over Wi-Fi or cellular networks to a cloud-based platform. Signal processing is required in order to extract information from the smart energy meter's raw sensor output. As part of the signal processing, noise is removed from the sensor data, the analogue sensor data is converted to digital format, and the household's power usage is estimated using the current and voltage values. Power Theft Detection: Any unauthorized individual messing with the meter can be found using the LDR sensor. When someone tries to cover the meter, the LDR sensor will notice a change in light intensity, which could be a sign of power theft. Web page: The web page displays the data it receives from the smart energy meter. User Interface: The interface can be designed to show data on energy use and notify the user if any unusual energy use is found. Alert and notification: If there is evidence of power theft, the appropriate authorities, such as the power company or customers, would be notified. The notice could come in the form of a push notification, SMS, or email. Energy management: The information gathered by the smart energy meter may also be utilized to control energy usage. In conclusion, a current sensor, voltage sensor, and LDR-based IoT-based smart energy meter would require the installation of sensors, data collection and processing, power theft detection, alert and notification, and energy managementreduced costs and improved the environment.



Hardware components

4.1. Solar panel

It comprises of photo voltaic cells. When the sun light or radiations \stall on them these PV cells transform these radiations in to \electrical energy. These PV modules utilize photons from the sun light and produce electrical energy. Which is then saved in batteries and supplies to homes, businesses etc. The suns radiation contains variances to manage these differences we employ specialized sensors.

4.2. Regulated power supply

The rectifier circuit, which transforms AC supply into DC (DC). It is a voltage source that provides consistent voltage to a gadget that operates with a known power supply. When using a regulated power source, the output is constantly around DC. It may be unidirectional or alternating. Linear DC power supply is another term for regulated DC power supply. Power supply Blocks such as stepdown transformer, rectifier, DC filter, and regulator are all found in this circuit.

4.3. Lithium battery

Lithium battery selection is critical to any project using solar panels. Since the microcontroller unit that always stays on and continuously verifies and submits the data needs at least a hundred milliampere of current for steady operation, there must be a hundred milliampere of current available in order for the microcontroller to function. When the sun is not shining due to monsoon, the battery capacity should last for 4–5 days. Another essential thing to remember is that the charge current must be higher than the load current. While it is rather uncommon to use a battery and connect 100ma of load, providing just a charge current that is less than that, it is possible. To ensure safety, the charging current has to be at least five times higher than the load current. However, in order for the microcontroller to use the voltage regulator, the battery voltage must be greater than what is required by the normal voltage regulator input voltage. A simple example of this might be connecting a 7.4 V lithium battery between the 3.3 V and 5.0 V linear voltage regulator (as linear regulator requires higher dropout voltage more than the LDO andswitching.)

4.4. Arduino Uno

This board incorporates an atmega328p microprocessor on a microcontroller base. ‘‘Uno” signifies ‘‘one.” The Arduino Uno features 6 analogue I/O pins that are supported by the Arduino IDE (Integrated Development Simply use a USB cable to connect it to your computer’s USB port. Also in addition to these Arduino Uno displayed in Fig. 2, additional Arduino Uno in Fig. 3 are required. Is built from a 16 mhz crystal oscillator, a reset button, and a Power Jack. It runs on 5 V. It is suitable for supporting the microcontroller (Fig. 4).

4.5. Voltage sensor

A sensor capable of detecting or recognising electrical or optical signals Fig. 6 shows the voltage sensor. This sensor is used to measure the voltage that is present in an item, and it is also used to check it. AC or DC voltage levels are mainly detected and measured using it. A voltage is supplied to this sensor, and the output is either a switch or an analogue sensor. Voltage signal, a current signal, or a combination of the two.

4.6. LCD display

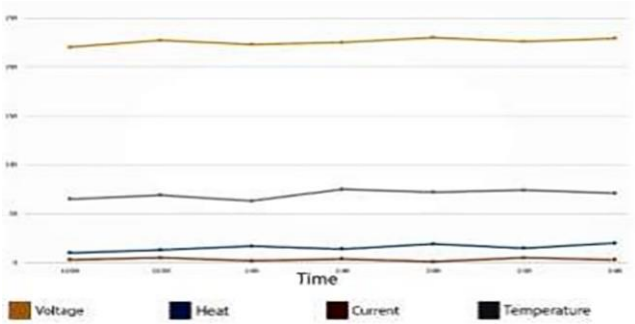
A liquid crystal display (LCD) is a display module widely utilised in a variety of electrical devices and circuits. In Fig. 7, you can see the LCD display utilised in this system. In general,

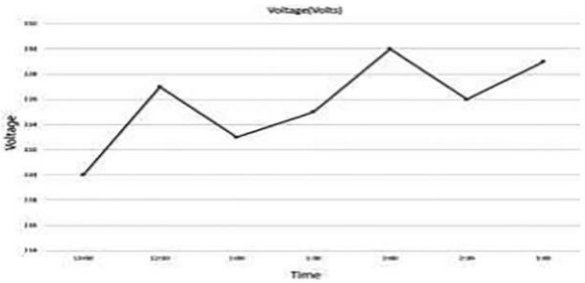
an LCD uses light to block. In this setup, we will be utilising a 16x2 LCD display. A The resolution of the display is 16 characters and 2 lines wide. Both solid and liquid create the LCD formation. It makes use of To make a visible picture on the screen, the liquid crystals are used (Fig. 8).

5. Experimetnal results

Both via the built-in LCD display on the entire system, and through the mobile device, the outcomes of our system may be seen. A unique mobile application is created The end result is that it gets the data from the cloud and shows the real-time data produces results for the user.

Fig. 5 is illustrate of the functioning model of the proposed system. The system aims to get the highest output power from the solar panels via the use of iot technology. After the installation of solar panels, the current and voltage are generated by the use of light energy. Sensors are used to record parameters. Voltage And current readings are shown With the assistance of iot technologies, LCD displays are already in production. Wi-Fi is plugged into the sensors, so we Linking to the Wi-Fi network allows you to see the readings on your mobile device. As long as If there are changes to the data or to the measurements, it will be immediately updated on our mobile devices. Internet of Things technology allows us to If you watch the panel's functioning, there may be a possibility to spot the issue when anything goes wrong.





Conclusion

A new system would be implemented in which the voltage and current parameters are stored and updated automatically. More or less, the daily or monthly study is simple and straightforward to do using the solar photovoltaic system's continuous tracking.

This idea allows us to take the reading from the energy meter with less physical labour, which saves money. The primary competitive aspect to increase market share in the current electricity markets will be service differentiation.. To assist the utilities in implementing this system, encourage customers to choose prepaid meters on a voluntary basis and provide tariff or non-tariff incentives to those customers who prepay their electricity changes. reduces the workforce. The project provides benefit customer and made more user-friendly so that the power department can send messages to customers informing them of their bills. For the benefit of the end user, it displays the constant statistics on webpage. Overall, this project work presents the design and operation of the Smart Energy Meter for Effective Energy Usage in Smart Cities, which can replace traditional meters in our environment.

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