Project Report

On

“SOLAR PANEL MONITORING SYSTEM”

Submitted in the partial fulfilment for the award of degree of

Bachelor of Technology

In

Electronics and Communication Engineering

By

Akshat Singh Paleshwar (18106003)

Atul Kumar Gupta (18106013)

B. Tech, VIII Semester

Under the guidance of

Mrs. Bhawna Shukla

Assistant Profssor

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

SCHOOL OF STUDIES IN ENGINEERING AND TECHNOLOGY

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

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Akshat Singh Paleshwar (18106003)

Atul Kumar Gupta (18106013)

DECLARATION

We the undersigned solemnly declare that this report of the major project work, entitled "**Solar Panel Monitoring System**" is carried out during the course of our study during VIII semester under the guidance of **Mrs. Bhawna Shukla**, Assistant Professor, Department of Electronics and Communication Engineering, School of Studies in Engineering & Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.).We further declare that this major project work is presented for the partial fulfilment of the requirement of degree of Bachelor of Technology in Electronics & Communication Engineering, School of Studies in Engineering & Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.)

Akshat singh paleshwar(18106003)

Atul Kumar Gupta(18106013)

APPROVAL SHEET

This major project report entitled "**Solar Panel Monitoring System**" by **Akshat Singh Paleshwar**, and **Atul Kumar Gupta** is approved for the partial fulfilment of the requirement of degree of Bachelor of Technology in Electronics and Communication Engineering.

Signature

Mrs. Bhawna Shukla
(Assistant Professor and Guide)

Examiners:

Signature

Dr. Soma Das
(Head of Department)

Date: .....

Place: Bilaspur

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF STUDIES IN ENGINEERING AND TECHNOLOGY

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

(A Central University established by the Central University Act 2009 No. 25 of 2009)

CERTIFICATE

It is certified that the major project entitled **"Solar Panel Monitoring System"** submitted by **Akshat Singh Paleshwar** and **Atul Kumar Gupta** in partial fulfilment of the requirements of the award of degree of Bachelor of Technology in Electronics and communication Engineering, School of studies in Engineering and Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur, is carried out by them in the Department of Electronics and communication Engineering during session 2021-22 under supervision and guidance of **Mrs. Bhawna Shukla**, Assistant Professor, Department of Electronics & Communication Engineering, School of Studies in Engineering & Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur CG.

Dr. Soma Das

Head of Department

Department of Electronics & Communication Engineering

School of Studies in Engineering & Technology

Guru Ghasidas Vishwavidyalaya, Bilaspur CG

ABSTRACT

The solar power monitoring system is the most important system which is used for renewable energy of sunlight. This system has the large future scope because the electricity is the most important need of the humans, they are used the electricity in their daily life. The solar power monitoring system used the Arduino Uno which is the microcontroller board. The solar energy is the renewable energy which is generated by sunlight. The sun is the main source of the solar system. The solar system uses the solar panels, which are used to generate the electricity. The solar panels are made up of pure silicon by creating some reactions on the carbon, silicon and hydrogen. Firstly, to generate the pure silicon it means that to generate the polycrystallin the carbon is added to the silicon and it forms the gases silicon then the pure silicon means polycrystallin. Then the hydrogen is added to that gases silicon then it forms the pure polycrystallin, then it separated in the number of plates that plates are called as the silicon wefers that silicon wefers are added to the solar panels, with the help of that panels the electricity is generated. The power generated from solar panel is to be efficiently monitored and managed to reduce the generation losses in solar power generation. Generally, we use solar plants to build in the locations where people can't reach on daily basis so this approach will help them to virtually control their systems from faraway places. It monitors the panel load by using the IoT technologies and the data which are received from the panels are send to the cloud through the internet for the future use. It also helps the remote users to monitor the solar power plant. The user can get the information about the current and previous average parameter like voltage, temperature and current. This will facilitate the fault detection and preventive maintenance of solar. In this paper we use the application Internet of thing (IOT) to control and monitor the solar power (renewable energy). This system is designed to solve the problem occur in solar power generation like management problem, maintenance and to reduce the time of repair. Using this technology, the cost of solar energy (renewable energy) generation reduces. This also provide real time information to the user help to monitor the system. The main purpose of this paper is that the solar panel can collect or capture maximum solar radiation and maintain the system more reliably and efficiently.

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1. INTRODUCTION

When we set up a solar power system we need to monitor it if the system gives us optimum power output this actually helps us to see if the system works efficiently or not. The monitoring system we are introducing here it actually helps us to monitor the real-time data of the Solar Panel be installed power home or working place. There are many e benefits of this system but in this introduction Part I am just explaining a few reasons why we ned the system. The IoT based monitoring system actually helps us to see if the Solar Panel is working properly and efficiently. Suppose if there is enough on lying there are too many dust on the Solar Panel or if it cannot Store the Solar Energy properly are if there is any fault the system will give us different reading than usual. This automated system can run and can be monitor from anywhere in the world by using internet. The proposed system and the components which are used to complete this project will be described gradually. the system we are proposing here will constantly monitor the Solar Panel and by using the IoT it will constantly upload the real time reading through internet.

The concept of internet of things is we can change anything like which are not connected with internet can we transform and make it smarter. The Solar Panel which is known by a hardware-based system can be transformed in a smart form by which we can make it connected with internet by using IoT. The main thing is by using internet of things we can connect any objects internet by wireless medium. Some examples like some devices we use in our daily life home appliances, cars and other things. These things can be e integrated with some sensors and other stuffs we can connected with the internet. Gradually the IoT have achieved different wireless sensor network sensors GSM and GPRS Wi-Fi and microcontrollers and other microprocessors etc. By using the internet of things we have to ensure that the system is enough secure. We have to ensure the security of IoT system otherwise it can be controlled by others and can be do to harmful things tour system. One of the huge benefit of using internet of things that we can monitor our system from anywhere in the world and it will provide us the real time reading or the real time scenario what is happening to our system. If we can maintain the security system and the system we want to integrate with the internet of things life will be easier so as the world is getting depended more on technology so we should also update our systems and connected with the internet of things so that you can be a more smart system for ourselves.

The Internet of Things (IoT) is a system of related computing devices, digital and mechanical machines, objects, people with unique identifiers and potential transfer of data over a network without

human-to-human or human-to- computer interaction. Physical objects those are no longer disconnected from the virtual world, but can be controlled remotely through Internet services. A smart world is nothing but Smart devices, Smartphones, Smart cars, Smart homes and Smart cities. “Smart” objects play a key role in the vision of IoT, since embedded communication and information technology would have the potential to revolutionize . With the growing presence of WiFi and 4G-LTE wireless Internet access, the evolution towards omnipresent information and communication networks is already evident . According to the International Energy Agency (IEA), Renewable energy will be the fastestgrowing source of electricity, in which wind and solar PV are technologically mature and economically affordable. But still there is increase in world’s demand for energy. Adopting Renewable Energy technologies is one of the advance ways of reducing the environmental impact. The latest edition of the IEA’s Medium-Term Renewable Market Report specifies the renewable energy growth about 13% more between 2015 and 2021 than it was in last year’s. The share of renewable energy in overall electricity generation will rise from over 23% in 2015 to almost 28% in 2021. Solar energy is universally available all over the world and can contribute to minimize the dependence of energy imports. In 90 minutes, enough sunlight strikes the earth to provide the entire planet's energy needs for one year. Solar PV leads to no greenhouse gas (GHG) emissions and other pollutants during operation. Solar has many benefits like system-friendly deployment, improved operating strategies, advanced renewable energy forecasting and enhanced scheduling of power plants and also investment in additional flexible resources, comprising demand-side resources, electricity storage, grid infrastructure and flexible generation. The traditional method focuses on the levelized cost of electricity (LCOE) which is a measure of cost for a particular generating technology at the level of a power plant that is no longer sufficient. About a million solar panels were installed every day around the world last year. Solar PV leads providing almost 40% of global renewable electricity capacity growth over the medium-term. Finally, in analyzing the evolution of electricity and energy-consuming sectors, it explores the prime role solar energy could play in the long-term future of our energy system. Applications of the monitoring system are the Rooftop Solar, Ground mounted Solar, Solar cities, Smart villages, Micro grids and Solar Street lights. Consumer Products like solar water heating systems, Solar home lighting systems, solar lanterns, solar pumps, solar mobile chargers, solar cookers, LED solar torch, solar RO plant, solar fan, solar Inverters, etc. can be monitored through this project. Commercial Products like Solar traffic signals, solar road studs/blinkers can also be monitored through the proposed system. In India, frequent power cut is very common. Due to this issue, it is

important to use renewable energy and monitoring it. By monitoring the energy forecast, households and communities who are using solar powercan utilize their energy production and consumption during good weather.

2. LITERATURE REVIEW

An online monitoring and control system for distributed renewable energy sources can be done by Android platform and other platforms also. The method which actually used the Bluetooth platform on the Bluetooth interface of different devices like mobile phones laptops and desktop Bluetooth module which actually creates a communication link for data exchange between the hardware and the power conditioning unit. There are different methods to monitor renewable energy generation system. Different communication module are used like Bluetooth communication module and Wi-Fi module which actually helps to share the real time data which are read from the hardware system. Development of an instant monitoring system of renewable energy generation that is constituted with a solar panel on current and voltage measurement of each reliable source the related values are measured by the voltage and I am sensor and processed by the Arduino or other microprocessor which it is transmitted via Wi-Fi module to an online platform. It also can be
monitored via personal computer and can be stored in a database or can be e monitor the real time data. There are many more system like the solar panel some people also try to create a monitoring system for the windmills which is also up renewable energy resources. These windmills are also controlled by the internet of things. This monitoring system actually helps us to monitor the real-time transmission of data and also verify if there is any kind of problem or issues with the system. We can actually in the system by synchronizing the hardware and the software.
Understanding how PV systems are developed, manufactured, sold, and managed throughout their lifetimes demands a value chain view. The concept of a value chain was coined by Michael Porter as a means of breaking down the activities of the firm into trategically relevant stages, processes, and relationships related to a product or service during the process of delivering “value” for a customer. Such activities involve product manufacturing, product delivery to consumers, and product disposal and/or reprocessing after use . Although initially developed to help understand the value creation process at the firm level, the value chain concept is now also used as a tool for understanding value

creation in industries and countries. At the industry level, a value chain analysis provides a comprehensive view of an industry, thereby supporting strategic and technology planning for incumbents and new entrants, as well as policy making at a higher level . The accelerated transition to a CE requires research on all relevant aspects of the value chain. In the literature, terms such as “circular value chain,” “circular supply chain,” “supply chain management in a circular economy,” or “closed-loop supply chain” are sometimes used interchangeably. Different from the traditional linear value chain explained above, we define the value chain concept in this article as the myriad of activities involved both in the supply and the take-back chain of the PV industry. Our base definition therefore covers “all stages of the life cycle from idea/concept, raw material sourcing, production, distribution, and end customer use to the point where the product returns to a biological or technical cycle, thus closing the loop” . A value chain perspective has therefore been chosen as means to identify hotspots for value creation at different stages of the PV lifecycle. Despite the holistic view proposed in this article, most of the published systematic literature reviews linked to solar PV have showed a technical focus, covering topics\ such as: advances in solar cell research and testing , energy losses and degradation of PV modules , forecasting of solar photovoltaic radiation and electricity generation , digital technologies for PV monitoring , and leaching of metals from EOL PV waste . Other review articles have been more market-oriented, highlighting the need for government interventions in supporting PV diffusion ; the factors influencing residential households’ adoption of PV systems ; and descriptions of the current PV market, its associated costs, and available technologies. Finally, a growing stream of literature focusing on the management of EOL PV modules has also emerged. For instance, suggests that monitoring and reporting systems at the national and regional level can support the identification and management of current and future streams of PV waste. The authors also stress the need for reverse logistics between geographically close nodes and recycling centers. Furthermore, while analyzing the drivers, barriers, and enablers for the EOL management of PV and battery energy storage systems, suggests that besides technology-related research, socio-economic research is also necessary to boost successful EOL implementation. Different from other review publications, the contribution of this article lies not only in showcasing the current barriers that impede PV and LIB reuse and recycling, and the overall achievement of industry circularity, but also in unveilinguntapped opportunities for different stakeholders along the PV value chain.

3. COMPONENT SPECIFICATION

3.1 SOLAR PANEL

Fig : Solar Panel

Solar energy begins with the sun. Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads.

Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing, and of course for the production of electricity by residential and commercial solar electric systems.

Solar panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current. The resulting energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a

directional current. This entire process is known as the Photovoltaic Effect. An average home has more than enough roof area for the necessary number of solar panels to produce enough solar electricrity to supply all of its power needs excess electricity generated goes onto the main power grid, paying off in electricity use at night.

Using solar panels is a very practical way to produce electricity for many applications. The obvious would have to be off-grid living. Living off-grid means living in a location that is not serviced by the main electric utility grid. Remote homes and cabins benefit nicely from solar power systems. No longer is it necessary to pay huge fees for the installation of electric utility poles and cabling from the nearest main grid access point. A solar electric system is potentially less expensive and can provide power for upwards of three decades if properly maintained.

Besides the fact that solar panels make it possible to live off-grid, perhaps the greatest benefit that you would enjoy from the use of solar power is that it is both a clean and a renewable source of energy. With the advent of global climate change, it has become more important that we do whatever we can to reduce the pressure on our atmosphere from the emission of greenhouse gases. Solar panels have no moving parts and require little maintenance. They are ruggedly built and last for decades when porperly maintained.

3.2 ARDUINO UNO

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output. Arduino UNO features AVR microcontroller Atmega328, 6 analogue input pins, and 14 digital I/O pins out of which 6 are used as PWM output. This board contains a USB interface i.e. USB cable is used to connect the board with the computer and Arduino IDE (Integrated Development Environment) software is used to program the board.The unit comes with 32KB flash memory that is used to store the number of instructions while the SRAM is 2KB and EEPROM is 1KB.

The operating voltage of the unit is 5V which projects the microcontroller on the board and its associated circuitry operates at 5V while the input voltage ranges between 6V to 20V and the recommended input voltage ranges from 7V to 12V.

Arduino UNO is easy to program and a person with little or no technical knowledge can get hands-on experience with this board. The Arduino UNO board is programmed using Arduino IDE software which is an official software introduced by Arduino.cc to program the board. The Arduino program is called a sketch which you need to unload into the board. The sketch is nothing but a set of instructions that allow the board to perform certain functions as per your requirements.

Arduino UNO

3.3 POTENTIO METER

A potentiometer is a device used to measure the potential difference in a circuit. The potential difference between two points in a circuit is the amount of work done to bring a charge from the first point to the second. When there is a potential difference in a circuit, the current flows through the circuit. It is a three-terminal resistor that acts as a voltage divider, and if only two terminals are used, it functions like a variable resistor or a rheostat.

Potentiometer is an electric instrument that is used to measure the EMF (electromotive force) of a given cell and also the cell's internal resistance. Furthermore, it is used to compare EMFs of different cells. It can also be used as a variable resistor in most applications.

The basic principle of the potentiometer is that the potential drop across any section of the wire will be directly proportional to the length of the wire, provided the wire is of the uniform cross-sectional area and a uniform current flows through the wire. When used as a potentiometer, connections are made to both ends as well as the wiper, as shown. The position of the wiper then provides an appropriate output signal (pin 2) which will vary between the voltage level applied to one end of the resistive track (pin 1) and that at the other (pin 3).

The potentiometer is a three-wire resistive device that acts as a voltage divider producing a continuously variable voltage output signal which is proportional to the physical position of the wiper along the track.

Fig : Potentio Meter

3.4 ELECTRIC MOTOR

An electric motor (or electrical motor) is an electric machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding. This interaction generates a force (as per Faraday's Law) in the form of torque which is applied to the motor's shaft.

Electric motors can be powered by direct current (DC) sources, such as batteries or rectifiers. Or by alternating current (AC) sources, such as inverters, electric generators, or a power grid. The working principle of the electric motor mainly depends on the interaction of magnetic and electric field.The electric motor is mainly classified into two types. They are the AC motor and the DC motor. The AC motor takes alternating current as an input, whereas the DC motor takes direct current.

Fig : Electric Motor

3.5 CURRNET SENSOR

A current sensor is a device that detects and converts current to an easily measurable output voltage, which is proportional to the current through the measured path. There are a wide variety of sensors, and each sensor is suitable for a specific current range and environmental condition. Among these sensors, a current sensing resistor is the most commonly used. It can be considered a current-to-voltage converter, where inserting a resistor into the current path, the current is converted to voltage in a linear way. The technology used by the current sensor is important because different sensors can have different characteristics for a variety of applications.

Current sensors are based on either open or closed loop hall effect technology. A closed-loop sensor has a coil that is actively driven to produce a magnetic field that opposes the field produced by the current being sensed. The hall sensor is used as a null-detecting device, and the output signal is proportional to the current being driven into the coil, which is proportional to the current being measured.

In an open loop current sensor, the magnetic flux created by the primary current is concentrated in a magnetic circuit and measured using a hall device. The output from the hall device is the signal conditioned to provide an exact (instantaneous) representation of the primary current.

Fig : Current Sensor

3.6 LCD

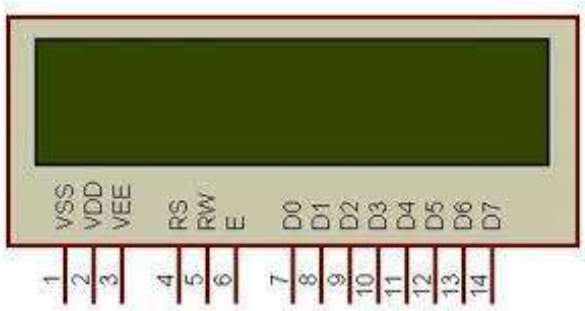


Fig : LCD

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. 6×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

4. SOFTWARE USED

4.1 PROTEUS

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

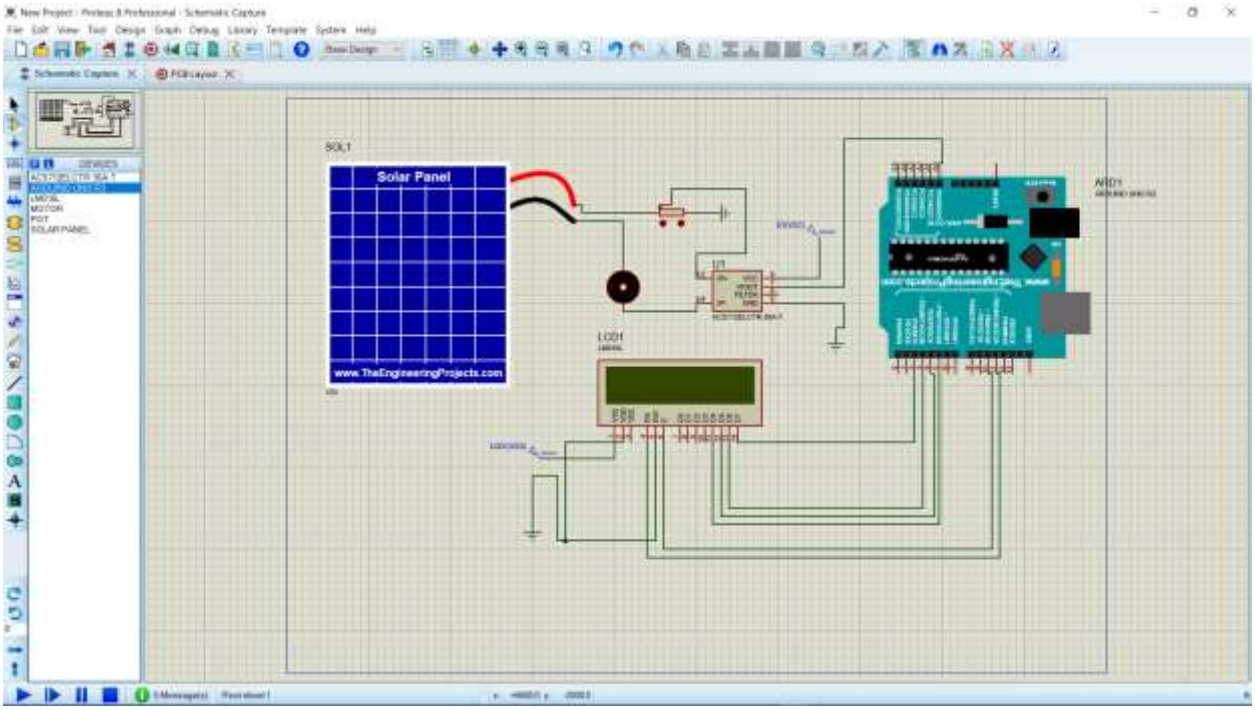


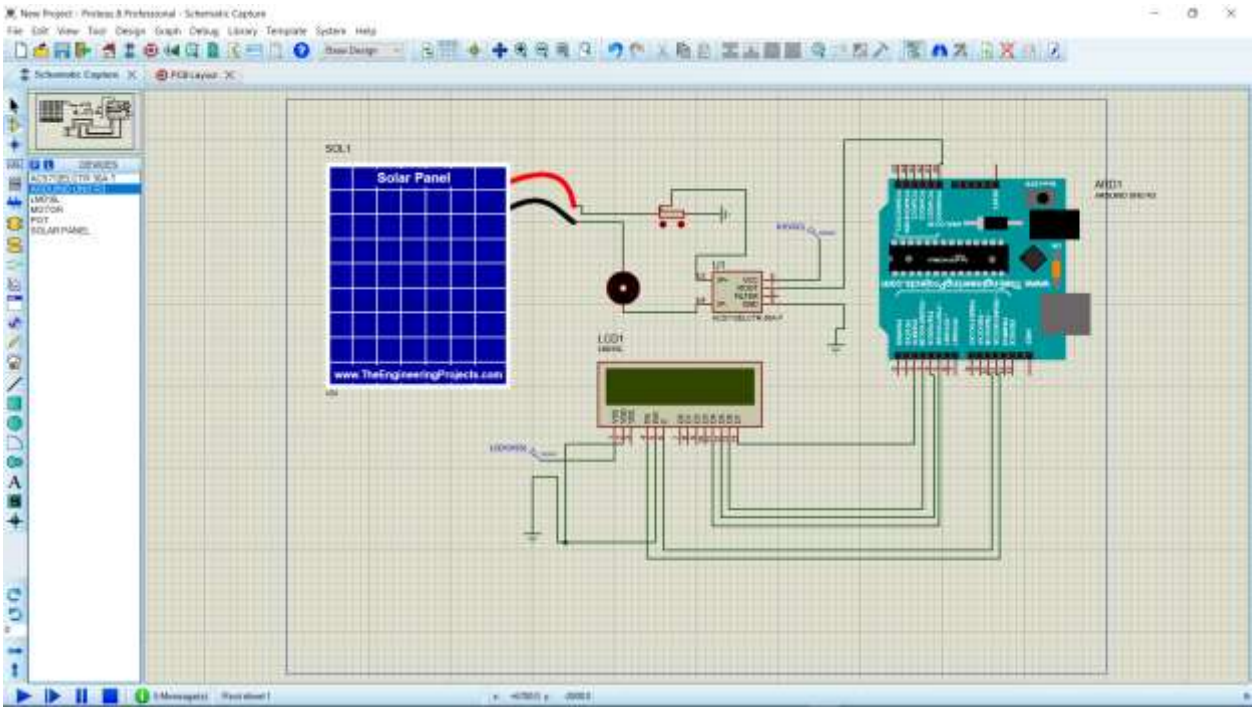
Fig : Circuit diagram of Solar Panel monitoring system on Proteus

4.2 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, othervendor 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.[6] The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution

5. SIMULATED CIRCUIT DIAGRAM



6. CODE USED

```
#include<LiquidCrystal.h>

LiquidCrystal lcd(11,10,5,4,3,2);

const int currentPin = A0;
int sensitivity = 66;
int adcValue= 0;
```

```
int offsetVoltage = 2500;
double adcVoltage = 0;
double currentValue = 0;

void setup()
{
  lcd.begin(16,2);
}

void loop()
{

  adcValue = analogRead(currentPin); // 0-1024
  adcVoltage = (adcValue / 1024.0) * 5000;
  currentValue = ( (adcVoltage - offsetVoltage) / sensitivity );
  int loadvoltage = currentValue * 12;
  int power = loadvoltage*currentValue*currentValue;



  lcd.print("Current = ");
  lcd.print(currentValue,2);
  lcd.print(" A");
  lcd.setCursor(0,1);
  lcd.print("Voltage = ");
  lcd.print(loadvoltage);
  lcd.print(" V");
  lcd.setCursor(0,0);

  delay(800);

  lcd.print("Power = ");
```

```
  lcd.print(power);
  lcd.print(" Watt       ");
  lcd.setCursor(0,1);
  lcd.print("                  ");
  lcd.setCursor(0,0);

  delay(1000);
}
```

7. WORKING

The working principle of the solar energy monitoring system is that solar panels absorb light energy and convert it into electrical energy, and then divide the electrical energy through the controller, provide it for direct use by monitoring and store it in the storage battery, and provide long-lasting power for monitoring.

When the sun is strong, the controller divides the electric energy converted by the solar panel into the one used for monitoring and the one stored by the battery;

When the sun is weak, the controller will take out the electric energy from the battery and provide it for monitoring when the electric energy converted by the solar energy is not enough to monitor the normal use;

When the sun is weak, the controller will take out the electric energy stored in the battery for monitoring.

A solar monitoring system works through the solar system's inverter. In most cases, companies sell their inverters with a patented, built-in monitoring software setup. You can, however, invest in third-party solar monitoring systems that provide a more in-depth analysis of your system's health and performance.

Depending on the system, solar monitoring can give you historical and real-time data on everything from how much electricity your panels are producing and how much you're using from the grid, to the temperature of your panels, and how much impact shade has on their output. It can also alert you to problems with your system that you'd otherwise miss until you receive an unexpectedly high power bill.

Not all solar power monitoring systems offer the same features. You'll often find that the in-built monitoring that comes with your inverter offers far fewer features than third-party monitoring systems sometimes just basic production monitoring.

Depending on your elected monitoring system, you may be able to track the following:

Solar energy production

Solar energy consumption

Grid exports and imports

Advanced system monitoring (circuit level, panel level, cost tracking, etc.)

8. ADVNTAGES AND DISADVANTAGES

8.1 ADVANTAGES

- Monitoring your solar panels can help you to optimize your home energy costs.

  Homeowners are starting to invest in solar panels for their homes. These panels can save homeowners money on their monthly utility bills, but they also provide other benefits. Monitoring the solar panel usage remotely is just one of these. Monitoring your solar panels can help you better understand and optimize the amount of time you're paying for power, and adjust your energy consumption during peak daylight hours.

- Protect Your Home With Solar Monitoring

  One of the most important benefits of solar monitoring is that it can protect your home against power outages. If something goes wrong with the system, an alert system will direct you to the issue straight away.

- In addition to detecting issues with solar equipment, solar monitoring systems can pinpoint repair solutions for the energy system equipment. Solar monitoring systems can also keep track of historical weather data. This data is valuable to homeowners since they can forecast how ongoing weather patterns might affect the overall energy production from their solar panel system.

- Leveling Your Energy Costs

  Another benefit to going solar is what the involves leveling your energy costs. This involves stabilizing your electric rate through renewable energy.Circuit level monitoring allows you to see how much power individual appliances draw from your system. This can help you identify any unexpected draws on the electricity produced by your panels and determine whether they're legitimate or a sign of an issue with your system.

- Maximised solar power production: Find out when your solar panels aren't producing power as expected and take action before it results in costly downtime.

- Increased solar self-consumption: As solar feed-in tariffs drop, it's becoming more important to increase your solar self-consumption during the day. A good monitoring system will alert you to the best time to operate energy-intensive appliances like your washing machine so you can use more of your self-generated electricity rather than draw from the grid.

- Understanding fluctuations in your energy bill: if you receive an unexpectedly high energy bill, your first thought might be that your panels aren't working properly. While that may be the reason, it could also be a number of other factors including consuming more energy, changing tariffs, or a billing error. A monitoring system will quickly pinpoint the reason so you can get your bills back on track.

8.2 DISADVANTAGES

- Cost

  The initial cost of purchasing a solar system is fairly high. This includes paying for solar panels, inverter, batteries, wiring, and the installation. Nevertheless, solar technologies are constantly developing, so it is safe to assume that prices will go down in the future.

- Weather-Dependent

  Although solar energy can still be collected during cloudy and rainy days, the efficiency of the solar system drops. Solar panels are dependent on sunlight to effectively gather solar energy. Therefore, a few cloudy, rainy days can have a noticeable effect on the energy system. You should also take into account that solar energy cannot be collected during the night.

- Solar Energy Storage Is Expensive

  Solar energy has to be used right away, or it can be stored in large batteries. These batteries, used in off-the-grid solar systems, can be charged during the day so that the energy is used at night. This is a good solution for using solar energy all day long but it is also quite expensive.In most cases, it is smarter to just use solar energy during the day and take energy from the grid during the night (you can only do this if your system is connected to the grid). Luckily your energy demand is usually higher during the day so you can meet most of it with solar energy.

- Uses a Lot of Space

  The more electricity you want to produce, the more solar panels you will need, as you want to collect as much sunlight as possible. Solar PV panels require a lot of space and some roofs are not big enough to fit the number of solar panels that you would like to have.An alternative is to install some of the panels in your yard but they need to have access to sunlight. If you don't have the space for all the panels that you wanted, you can opt for installing fewer to still satisfy some of your energy needs.

- Associated with Pollution

Although pollution related to solar energy systems is far less compared to other sources of energy, solar energy can be associated with pollution. Transportation and installation of solar systems have been associated with the emission of greenhouse gases.

- Reliability

  One drawback of solar energy is that it relies on the sun, electricity cannot be generated during the night, requiring you to either store excess energy made during the day, or connect to an alternate power source such as the local utility grid. This means that you will have to pay more on top of the high cost of the solar panels.Clouds and storms also restrict the amount of energy you can produce by blocking light rays that would have otherwise been absorbed by the solar panel.

- Inefficiency

  According to the Qualitative Reasoning Group with Northwestern University, most solar panels on people's houses convert only 14% of their available energy into power. Even today's most efficient solar panels convert only 22% of their available energy into power.According to the second law of thermodynamics, solar cells will never reach 100% efficiency. The highest theoretical maximum efficiency is 85%, and that's with mirrors and motors to follow the sun.

9. CONCLUSION

In this paper, all the updated works on the solar PV monitoring system are discussed. It has been found that the Internet of Things (IoT) -based monitoring system has revolutionised the field of solar cell data acquisition. The IoT-based system can conduct maintenance of the PV cells with monitoring. The integration of technology has produced a mix of the best relevant data of a PV cell. A research even proposes to monitor every cell of a solar cell panel accurately. This research has much importance as it also helps to identify the faulty components in advance, and accordingly, the replacement of the component could be arranged without disturbing the ongoing production of solar energy. Monitoring, manipulating the data, and control of the operation of a solar PV system have been studied in detail. A proposed smart system function is reported to realize in real-time. In this paper, problems related to inflexibility, poor manageability, mean time to repair, and difficulty in maintenance are focused on. To overcome these issues, the effective design and development of a smart intelligent system are reviewed for monitoring, controlling, and administrating the solar photovoltaic (PV) system. Realtime and low-cost monitoring of the solar PV system is presented with a new architecture of NodeMCU

connected to Nod-Red. This system is accurately able to measure the production of energy in terms of voltage, current, and power. The NodeMCU component is an open-source IoT platform; a Wi-Fi system on a chip-based working capability. It is a highly integrated chip designed to provide internet connectivity confined to a small package. It is reviewed that the output power of the PV system can be significantly improved by properly monitoring and tracking using IoT and other networking systems. This will help in the selection and installation of a PV system in small-scale applications.
While solar energy is considered an inexhaustible renewable resource, the way we currently harness that energy has many disadvantages from being unaffordable to inefficient. However, solar technology is still in its infancy and many good ideas are beginning to surface.

For example, research on energy storage issues has found two different methods that could be used to store electrical energy in the future.

Finding inspiration in existing technology, scientists are creating flow batteries that use small organic molecules that help rhubarb plants store energy, called quinones, rather than the toxic and very expensive metal vanadium ions. Researchers predict this technology could take the present cost from $0.02 per kilowatt-hour down to $0.0025 per kilowatt-hour.

The other method, which is really quite ingenious, takes the solar energy produced to create methanol from carbon dioxide instead of electricity. The plan is that a plant would burn the methanol as fuel, which would convert it back to carbon dioxide that would be re-captured and stored. The goal is to reduce emissions by recycling carbon, instead of letting escape into the atmosphere.

One thing is for sure though. Solar energy (for things outside of basic outdoor solar lights) still has a long way to go before it is affordable, efficient, and environmentally friendly.

10. FUTURE SCOPE

In this contemporary world, electricity has become an essential part of life. With each passing year, the power usage of every household has increased threefold as compared to the energy resources. In order to accommodate these surging needs, people are switching to a sustainable source i.e solar energy. Photovoltaic solar technology has become much more prominent because of huge availability, lower costs, and quick installation.

However, the energy output continues to be a big barrier to the widespread adoption of solar power. This is why EPC companies are on a lookout to find tools that can help mitigating the higher cost of maintenance and regulating the power usage of solar panels. This way, they can help users unleash the potential of a solar system in true sense and reap maximum rewards from the installation.

The basic parameters which affect the output of a solar solution are current, voltage, irradiance and temperature. Therefore the real-time solar output surveillance system is essential to strengthen the effectiveness of the PV system by weighing it with the experimental outcome to trigger preventative measures.

This is where the Internet of Things comes into play. IoT applications in clean energy generation include smart sensors that are linked to the production, transmission and distribution devices. These instruments allow solar investors/ commercial clients to remotely track and manage the operation of the entire solar system in real time. It minimises the operational expenses and reduces our reliance on fossil fuels.A more versatile remote monitoring, analysing, and maintenance of the solar PV plant is a future need. A new approach to the application of AI-based programming is needed to be incorporated into the present monitoring system. The present mismatch of the output signal of solar PV cells due to the Internet-based receiver and analyser requires serious attention. IoT provides the most appropriate solution in monitoring solar PV systems according to the current technological advancements. These systems are more energy-efficient and save manpower and labour costs. The use of IoT in the developed system enables more prospects in these monitoring systems. This also provides advantages in terms of the system’s uniqueness and flexibility and adding additional sensors and devices without facing incompatibility issues. Some parameters like the solar irradiance, load power consumption,

current output, and AC voltage, and the solar panel's output can be evaluated by using additional sensors in the monitoring system. Also, the IoT monitoring system can be utilized to improve the traditional solar-based electric vehicle systems for converter designs and the adoption of appropriate MPPT (Max PowerPoint Tracking) methods

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