JOURNAL PUBLICATION OF INTERNATIONAL RESEARCH FOR ENGINEERING AND MANAGEMENT
(JOIREM)
VOLUME: 10 ISSUE: 04 | AUG-2022

# IOT Based Solar Energy Monitoring System

Nilakshi Chandratre[1]

Student, Department of Electrical Engineering
KKWIEER, Nashik, India

nilakshi.chandratre369@gmail.com

Hrushikesh Pawar[2]

Student, Department of Electrical Engineering
KKWIEER, Nashik, India

hrushikeshpawar66@gmai.com

Pratiksha Purane[3]

Student, Department of Electrical Engineering
KKWIEER, Nashik, India

pratikshapurane246@gmail.com

Prof.S.A.Sagare[4]

Assistant Professor, Department of Electrical Engineering
KKWIEER, Nashik, India

sasagare@kkwagh.edu.in

**Abstract—** Renewable energy resources have became prominent solution to help the world with depleted conventional energy sources, to over through the energy crisis and reduce the emission of harmful gases to zero. Solar energy is now being used in wide applications all over the world, the popularity gained by solar energy applications gives the purpose for connecting this solar energy devices with other devices and software over the internet for exchanging the operational data of solar applications. There are many issues related to power transmission and power generation, like power failure, high tariff rates, and harmful emissions with hazardous environmental impacts. Solar energy is a reliable source with low maintenance and being an emerging technology we can improve its efficiency by IOT application. In this paper IOT is used for monitoring the solar energy systems. This paper will help to understand the need of monitoring and its advantages.. The paper involves the results of the experiment performed using by using Arduino Uno R3 as a microcontroller and sensors with Wi-Fi module. This Wi-Fi module then uploads the data on servers that is then accessed remotely, which will monitor the variation in the power flow parameters and efficiency of the system.

***Keywords— IoT(Internet of Things),Solar Energy, Arduino Uno R3,Remote Monitoring.***

## I. INTRODUCTION

The internet of things is a forthcoming technology that allows a device to be monitored using cloud server. Besides Power generation is the major issue around the globe due to depletion of conventional energy sources and increasing rate of global warming. Energy from sun can be harnessed as a primary energy source in various applications as an important renewable energy source.The smart monitoring will help the user to analyze and keep track of malfunctions. The motivation for this paper is to detect if the system faces any issues like hot spot conditions, shadowing, dusting which can reduce the output of the system nearly by 40%.. These faults can be detected by keeping track on the system and its values. Use of IoT will be more convenient to increase the efficiency of solar energy system. IoT is the network of physical objects that embedded with sensors, software for the purpose of exchanging the information and data. The system monitoring the power flow of the system will give Real-Time data as well as historical data so that the errors can be minimized before it can cause any damage. .Given system

IoT based solar energy monitoring system where a solar panel with will be generating power for load, a DC-DC buck converter is Arduino Uno R3 is given the analog inputs through voltage divider, current sensor ACS712 for sensing voltage and current respectively and LM35 temperature sensor mounted on panel for temperature measurement. The outputs from Arduino will be then 0displayed on 16X2 LCD Display and sent to cloud by ESP8266 Wi-Fi Module. Irradiance for region is assumed to be a standard value of 1000 W/m^2.

The monitoring platform is based on each renewable source's current and voltage measurements. The readings are measured using the built sensing circuits. The processed parameters are then sent via USB to a personal computer (PC) so that they can be kept in a database and the system can be monitored instantly. Microsoft Visual Studio is used to create the observation software. At a glance, the Net platform allows system administrators to monitor the amount of energy generated and the current state of each renewable energy source [2]. The system has better user interfaces that leverage information and communication

technologies such as Web technology, as well as the integration of management and remote monitoring functions into one system. The system has become even more reliable when it was converted to a DC power supply and a mutual substitution function was added [1]. The cost of renewable energy equipment is decreasing due to technological advancements, which is promoting large-scale solar photovoltaic installations around the world. Because the bulk of them are situated in inaccessible areas and hence unable to be monitored from a dedicated site, advanced systems for automation of the plant monitoring remotely using web based interfaces are required [3].

## II. METHODOLOGICAL APPROACH

Wired sensors/components have been used in almost all monitoring systems. While they are effective, the cost and maintenance requirements have limited the number of sensors that can be installed on a particular system. Hard wire expenses and associated maintenance are significantly decreased with wireless IoT deployments, allowing for greater data collecting, monitoring capabilities, and later learning/AI applications.Many systems communicate via cellular networks or WiFi. Cellular coverage is a popular option because of its vast geographic coverage, but it is also somewhat expensive. WiFi has its own set of issues, since many IT departments are hesitant to allow third-party IoT devices onto their networks due to security concerns. Commercial solar power systems frequently include a subscription.

The internet of things. According to reports can connect any devices like computers, smartphones, sensors etc. to the internet using technologies such as microcontrollers, transceivers and information and network protocols. As a result as compared to manual supervision a communication network with IoT may provide feasible monitoring and control of PV system in larger scale or even in domestic use. There are different methods which are being used for solar monitoring system. The IoT platform like Thingspeak, AWS IoT analytics, datalog, Google cloud IoT core are available for the data transfer. This data can be supervised remotely. This platform allows the user to visualize the data in graphical representation. In some systems they collect the data from various sources and give alerts in case of any complication.

## III. SYSTEM DESIGN

The system allows the user to monitor the parameters of solar panel. The parameters that can be monitored are current, voltage, temperature, power and energy. These parameters are monitored on an interval of time. The interval of time can set as per daily basis or on a fixed gap of time. The parameters are measured using different sensors. The sensor are ACS712 for current, voltage divider for voltage, LM35 for temperature. The mechanism for each is show in the above chapters with description. This hardware setup includes a PCB(printed circuit board), solar panel, charger controller, battery, dc-dc buck converter. The PCB in the system includes all the sensors with an IC ATmega328P which acts as a microcontroller and Wi-Fi module ESP8266.

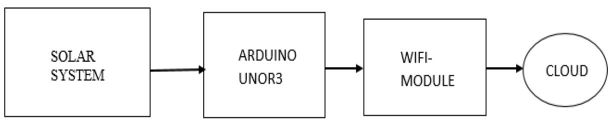



**Figure 1 Block diagram of system**

Current and voltage generated during on load condition are measured to monitor the power output and power flow through the load connected to solar panel. The ideal ambient temperature for a panel is 25 º C thus the ambient temperature is measured to monitor the effect of temperature on power generated as the temperature increases power output decreases rapidly. Similarly insolation affects the maximum power as the insolation increases power output increases. The power generated will charge the battery to supply input power to load. Here are the calculations for charging time and charging current of the battery.

JOURNAL PUBLICATION OF INTERNATIONAL RESEARCH FOR ENGINEERING AND MANAGEMENT
(JOIREM)
VOLUME: 10 ISSUE: 04 | AUG-2022

## IV. HARDWARE SETUP

The Hardware of the system is shown below. The system allows the user to monitor the parameters of solar panel. The parameters that can be monitored are current, voltage, temperature, power and energy. These parameters are monitored on an interval of time. The interval of time can set as per daily basis or on a fixed gap of time. The parameters are measured using different sensors. The sensor are ACS712 for current, voltage divider for voltage, LM35 for temperature. The mechanism for each is show in the above chapters with description. This hardware setup includes a PCB (printed circuit board), solar panel, charger controller, battery, dc-dc buck converter. The PCB in the system includes all the sensors with an IC ATmega328P which acts as a microcontroller and Wi-Fi module ESP8266.

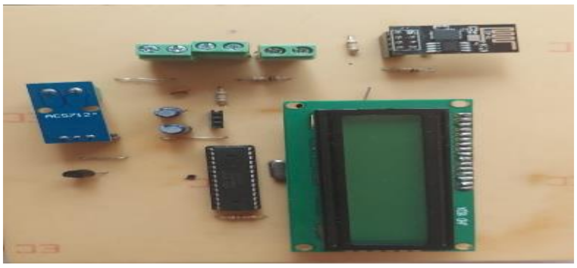


**Figure 2PCB front view**

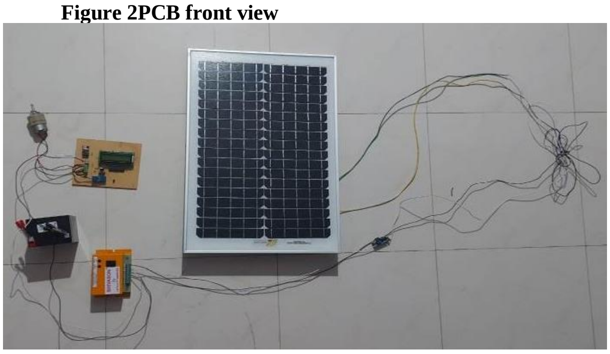


**Figure 3Hardware Setup**

TABLE I. COMPONENTS USED

| ***Sr. No.*** | ***Component Name*** | ***Specification*** |
|---|---|---|
| 1. | Solar Panel | 25 watt,12 V |
| 2. | DC-DC buck converter | 9-36V |
| 3. | Charge controller | 12V,5A |
| 4. | Lead-acid Battery | 12V,5Ah |
| 5. | Arduino UNO R3 | 5V |
| 6. | ACS712 | 5A |
| 7. | LM35 | -55 °C to +150ºC |
| 8. | LCD display | 16x2 |
| 9. | Wi-Fi Module | 2.4GHz-2.5GHz |
| 10. | Resistors | 1kohm |

## V. IMPLEMENTATION

The proposed system designed to monitor the PV System with output power 25Watt with general specifications as follows:($V_m$:17.08 V, $V_{oc}$:21.17 V, $I_{sc}$: 1.26 A) . For this system with the panel the DC-DC buck converter and a 12V solar charge controller are connected before the battery. The charging time for the battery will be 5 hours according to the system. The expected energy output of system considering 5 peak sun hours a day is 93.75 W-hr/day. Now to check the operation of the developed system and also to check whether it actually monitors the required parameters, the PV system is placed under real environment to generate the required output. Battery in the system is connected to load where current sensor and voltage divider are connected to monitor the current voltage and calculate the power and energy output. The sensor data in calculated and collected by Arduino Uno R3 and uploaded to Thingspeak platform using Wi-Fi module as IOT protocol. Final aim of this testing will be to monitor the output current, temperature, voltage and energy of system in working conditions.

The parameters to be monitored are

1. Maximum voltage
2. Maximum current
3. Temperature
4. Energy
5. Power output

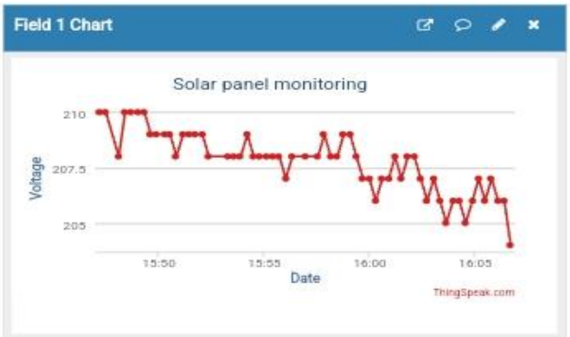
TABLE II. PARAMETERS ANALYSIS

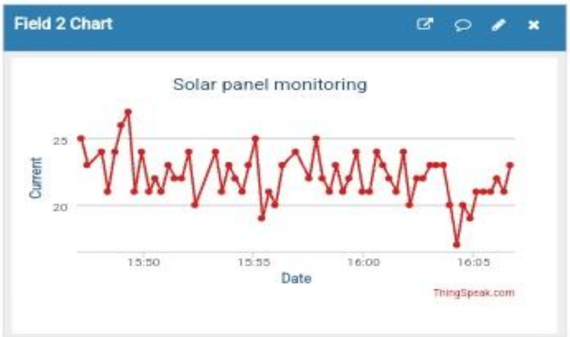
| Parameter | Expected Value | Actual Value |
|---|---|---|
| Maximum voltage | 17.08 V | 15.75 V |
| Maximum Current | 1.18 A | 0.78 A |
| Power | 25 W | 25 W |
| Temperature | 25°C | 35°C |

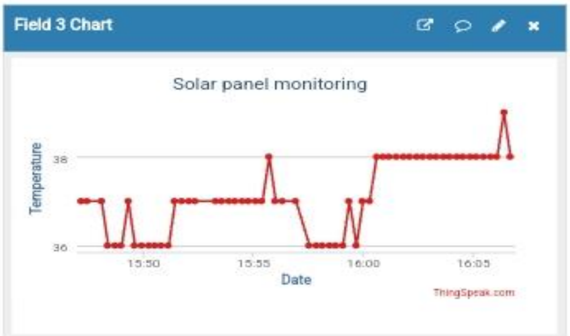
On applying this system to the solar PV system actual values were obtained with little variation as mention in the above table.

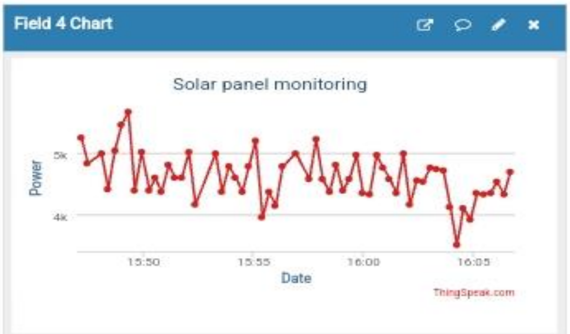
## VI. RESULTS

The graphs provide the information about the working and generation data by parameters to the user focusing on the real time generation parameters.




Field 1 for Voltage:

The results of voltage divider circuit in the above graph of voltage Vs date is obtained. The graph shows the variations in the voltages that are nearly similar to the expected values.

Field 2 for Current:

For the current values the current sensor ACS 712 is used. In the above graph the values of current are achieved. This graph shows the result curve which is as predicted.

Field 3 for Temperature:

The above temperature Vs time graph shows the constant value of the temperature which is got from the system during the operational time.

Field 4 for Power:

The power Vs date curve shows the power that produced from the values of current and voltage. This curve shows total power output variation during specific period of time.

For observing the data with the aim of longer time the system can work at day time efficiently and the data will give output according to the load. Hence, individual can analyze the output in different weather conditions and get the enough output for the load.

## VII. CONCLUSION

For this paper the 25 Watt solar panel is monitored for power, current, voltage, temperature. The energy generated from solar panel is being stored in 12V 5Ah lead acid battery which is supplying power to 10W DC servo motor. The sensor output data graphs for parameters being monitored were obtained using Thingspeak platform. This project justifies the ease of use that Internet of things bring to the solar energy application where user can record, analyze the data and predict the energy generation for the Solar energy System installed. The results of this project can be further used to enhance this project. The monitored values can be useful in predicting the values of parameters for system in use, parameters like current voltage and max solar output by the system. The predicted values can be conveyed to the user to decide and manage the usage. This solar energy monitoring is majorly used for PV applications like small scale or large scale solar power plants where the monitoring is majorly done using inverters. The systems like one made in this project can be useful and feasible for the smaller systems like solar streetlights, solar agricultural pumps and other solar applications.

## REFERENCES

[1] Yoshihiro Goto, Masaki Kiya, Yo shichika, Mizutani, Tatsuo Sakai, and Yuji "Integrated Management and Remote Monitoring System for Telecommunication Power plants with Fully DC-Powered Center Equipment" 2007 IEEE

[2] Ersan KABALCI, Alper GORGUN, Yasin KABALCI "Design and implementation of a renewable energy monitoring system" 2013 IEEE

[3] Soham Adhya, Dipak Saha, Abhijit Das, Joydip Jana, Hiranmay"An IoT Based Smart Solar Photovoltaic Remote Monitoring and Control unit" IEEE, 2016, 978-5090-0035-7/16

[4] Suprita M. Patil, Vijayalakshmi M., Rakesh Tapaskar "An IOT based Solar energy Monitoring System" IEEE, 2017, 978-5386-1887-5/17

[5] Ambuj gupta, Rishabh Jain, Rakshita joshi, Dr. Ravi Saxena "Real time remote solar monitoring system" 978-15090-6403-08/17/2017 IEEE

[6] Ankit kekre, Suresh k. Gaware "Solar Photovoltaic remote monitoring system using IOT" International conference on recent innovations is signal processing and Embedded systems (RISE 2017) 27-29 October 2017

[7] W Priharti "IoT based photovoltaic monitoring system application" 2019 J. Phys.: Conf. Ser. 1367 012069

[8] Mubashir Ali, Mahnoor Khalid Paracha "An IOT based approach for Monitoring Solar Power Consumption with Adafruit Cloud" Vol. 4, Issue 9,ISSN No. 2455-2143

\[9] https://smartxbrains.in/