

## IOT BASED RENEWABLE ENERGY MONITORING SYSTEM

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### Abstract

Due to the increasing dependence on renewable energy and related systems it is important to closely monitor and identify the governing parameters for efficiency with respect to environmental circumstances (temperature, irradiation. etc.). To maximise energy production, it is crucial to conduct in-depth analysis with an emphasis on the properties of photovoltaic devices. In-order to obtain the parameters like Power, Energy and Efficiency basic parameters are required such as voltage, current and system specific (inverters and converters) parameters like losses and efficiency. Manually, using analog measuring devices to measure voltage and current calculating and making a note of it and plotting a graph is an arduous and time-consuming task. So, to overcome this trying to develop an IOT enabled device which does all the above-mentioned work and makes the work easier permits monitoring the performance characteristics on mobile application with no extra work to be done by us. Using this device and inbuilt algorithms can introduce and keep a track of other related parameters like; power output, charge conditions, used power, temperature, irradiation, wind speed variation etc. The results can be readily printed using blue tooth from mobile/ transferred to other mediums. This whole process of sending the data after processing takes place on internet, thus no extra medium is required and only one thing that is to be ensured is that availability of Continuous power supply for the base monitoring station/ micro-controller. The system shall be developed in two parts: base monitoring and relaying and mobile application.

**Keywords.** renewable energy, Internet of Things, Monitoring, micro controller, photovoltaic device.

### 1. INTRODUCTION

Renewable energy is the energy that is collected from the renewable resources or in other words energy collected from a source which is not exhausted when used. However, the amount of energy available per unit of time is limited. The major types of renewable energy are solar energy, wind energy, hydro energy,

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biomass energy and geothermal energy [1]. So, humans are very dependent on these type of energies and related systems it is important to closely monitor the consumption and usage of these type of energies [2]. To monitor and optimize energy production, detail investigation should be carried out with an emphasis on photovoltaic device properties. So manually using analog measuring devices to measure voltage and current calculating them making note of them takes a bit lot of time. So, a IOT enabled device is developed in this project to do all above work and permits monitoring the performance characteristics. This project helps to monitor them through mobile application and values get updated in a excel sheet time to time. Monitoring them can be done from anywhere in the world by connecting to internet. IOT (Internet of Things) refers to the interconnection via internet of computing devices embedded in everyday objects, enabling them to send and receive data. In other way IOT enables the objects to be sensed, while also controlling it remotely, which enables better interaction of physical world to the computers. This would improve the accuracy, efficiency with limited human intervention. THINGS in IOT include HARDWARE + SOFTWARE + SERVICE. IOT is not just about getting devices connected.

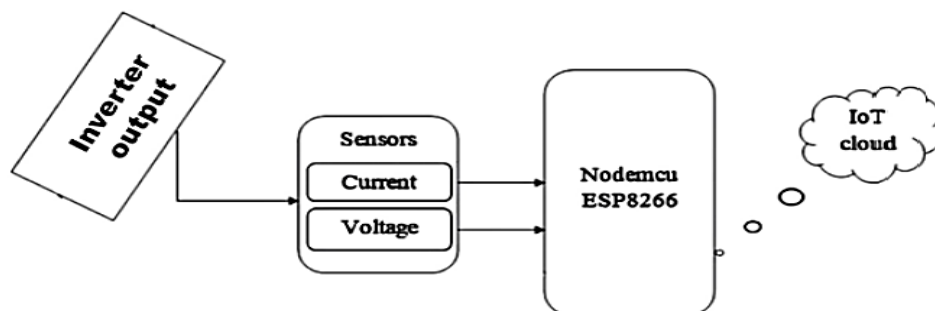


Figure 1. Block Diagram

IoT is not just about getting devices connected. It is more about exchange of meaningful information from one device to another to get another meaningful accomplishment. IOT is not one technology, but it is a collection of technologies and domain knowledge and hence interpretation matters a lot, otherwise there are going to be a lot of misconceptions.[3] Apart from renewable energy monitoring there is also a need of a solution which can monitor and manage the existing source of energy present. This solution will closely monitor energy consumption of the home residents and help in reducing the energy cost and energy losses.[3] Electricity, like water and food, is a need in today's world. We urgently require Electricity powers heating, lighting, refrigeration, public transportation, and all household appliances. The use of energy is increasing daily, but the availability of

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energy is decreasing. As a result of the constant decrease, various alternative energy sources are used to meet power needs and produce power. Non-renewable sources are used in the other approach. One method employs renewable resources, while the other uses non-renewable resources. Non-renewable resources include solar, wind, and tidal energy. As a result, solar and wind energy are frequently referred to as a long-term power source. As a result, an IoT-based renewable energy monitoring system is being proposed to address the need for performance monitoring.

### 2. METHODOLOGY

First thing that needs to be done is, calibrating the voltage sensor. Here calibration of voltage means positioning the pin available on the sensor to provide an accurate sine-wave output.

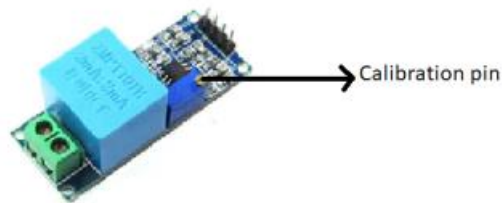
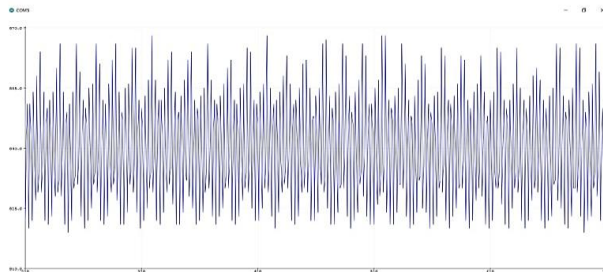


Figure 2. Voltage sensor

Calibrating the module by its Potentiometer (Calibration pin), you wire the module, plug the Arduino and upload the code onto Arduino and do not forget to place the measuring probes to the power socket and you already know the voltage over. By running the code and positioning the pin available on the sensor it leads to the accurate sine wave output which is required here.

The next step is to connect to google spread sheet by means of esp32 module. Firstly, create a new spread sheet in google drive and note the id of that sheet and then using this id we would make request to add rows into google spread sheet we need to add a json file in the extension part of google spread sheet.



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Figure 3. Calibrated module sine wave output

Here while connecting to Arduino IoT cloud, we need to first setup the device Esp32. At the end of setup you will be asked to enter a name for the board and then after entering, you will be provided with device id and secret Key. And it is to be noted that secret key cannot be recovered after noting them done you need to click on continue. And you make your own thing and then a dashboard for it and enter the coding part for it and then by entering the Wi-Fi details and security key which is already available after device setup. And you will be also asked for device network name and password on which this device gets connected and will be available for us to monitor the data.

While calculating current flow through the sensor we must know the maximum rating up-to which the sensor can measure. If it is a 5A current sensor, then it has different magnitude of voltage at the output for 1A of current flow through the sensor. The output voltage for different rated current sensors is provided by the manufacturer itself. For example, a 30A current sensor (ACS712 Hall effect Sensor) would result in 66mV/A.

After calculating the values of current, voltage and power these values are updated on the mobile application through the help of Arduino IOT cloud which is connected to the mobile application and updated on the google spreadsheet which is connected to our Arduino. These are the two sources of applications to monitor on our mobile. In this project a relay is added to provide time delay function and to use it as a switching power source whenever needed.

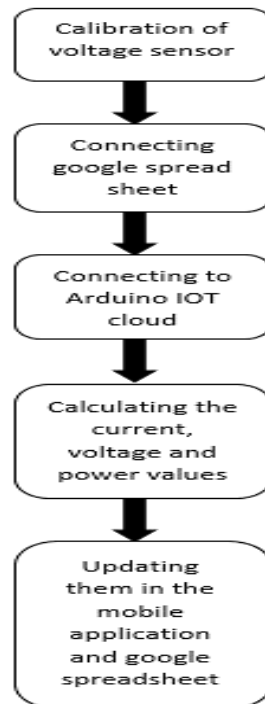


Figure 4. Methodology used

### 3. RESULTS

According to the algorithm energy source that is being used is monitored in two different ways and this is achieved through IOT. The two different ways are

- Monitoring the readings on google spread sheet.

Timestamp	Purpose	Power	Voltage	Current
February 11, 2	Major	7.68	244.92	0.03
February 11, 2	Major	7.68	260.44	0.03
February 11, 2	Major	7.68	255.97	0.03
February 11, 2	Major	7.68	245.01	0.03
February 11, 2	Major	7.68	249.81	0.03
February 11, 2	Major	7.68	243.99	0.03
February 11, 2	Major	7.68	254.74	0.03
February 11, 2	Major	7.68	256.76	0.03
February 11, 2	Major	7.68	243.77	0.03
February 11, 2	Major	7.68	255.15	0.03
February 11, 2	Major	7.68	255.7	0.03
February 11, 2	Major	7.68	252.93	0.03
February 11, 2	Major	7.68	250.53	0.03
February 11, 2	Major	7.68	252.9	0.03
February 11, 2	Major	7.68	253.62	0.03
February 11, 2	Major	7.68	252.93	0.03

Figure 5. Readings in Google spread Sheet

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- Monitoring the readings on Mobile application.

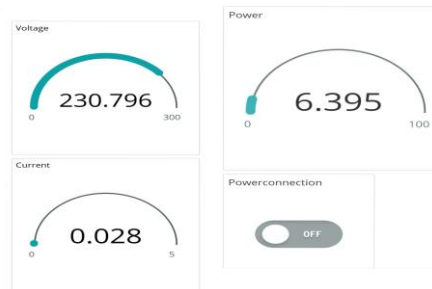


Figure 6. Readings in Mobile application

#### 4. DISCUSSION

Economic considerations are one of the key reasons businesses and governments are investigating IoT's potential for energy efficiency. Everyone in the supply chain benefits from improved spending and investment control, waste reduction, and real-time power usage monitoring thanks to smart metres and data-driven predictions. To comply with new standards aimed at reducing emissions, the energy sector has experienced considerable changes. Companies are gradually incorporating IoT energy consumption and management software and other solutions into their operations in order to decrease their carbon footprint — optimise resource use, measure and analyse environmental impact, and establish long-term plans targeted at net-zero targets.

Companies utilise IoT not only to employ analytics tools to assess how effectively companies are complying with existing environmental standards, but also to manage energy in their everyday operations. Modern SaaS platforms include analytics capabilities that demonstrate if clients are eligible for incentives and industry certifications.

Professionals in this industry, both downstream and upstream, recognise that a shift to green energy is unavoidable and are taking steps to incorporate clean energy strategies into their operations. By utilising energy monitoring sensors, performance, and power consumption data, utilities, for instance, can better understand how to maximise the use of renewables in their services and execute energy conservation efforts.

#### 5. CONCLUSION

The IoT based Renewable Energy Monitoring System has been designed and implemented satisfactorily. The presence of each module has been carefully

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reasoned out of place adding to the optimal running of the unit. This Energy Monitoring System is designed to provide an easy way to monitor the amount of energy being generated at every instant of time.

Because of the growing reliance on renewable energy and related systems, it is critical to keep a careful eye on and establish the governing parameters for efficiency in relation to environmental circumstances. In order to optimise energy output, extensive study, focused on the features of photovoltaic devices, is critical. Manually measuring voltage and current with analogue measuring instruments, calculating and recording the data, and displaying a graph is a tedious and time-consuming operation.

So, to address this, we are aiming to design an IoT-enabled gadget that accomplishes all the above and makes the job easier by allowing us to monitor performance parameters on a mobile application without having to do any extra effort. The only thing that must be ensured is that the base monitoring station has a continuous power supply.

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