# Smart Grid Management in Photovoltaic System using Wireless Sensor Network with IoT

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***Abstract-*** Wireless Sensor Networks (WSN) making our day-to-day life more innovative and smart, by integrating it influences in various comfort, health and safety applications. Smart grid had achieved a more flexible as well as efficient electricity system with advancement in information and communication technologies. Accordingly, solar cells are the well-known distributed renewable power generators, but compared to the traditional energy production scenario they are difficult to predict the demand-supply problem. It paths a way for bidirectional energy flows in the low-voltage power grid but, it results in drawbacks like voltage violations and grid instabilities. The above mentioned requirements enable the need of a smart grid extension, which should be a better smart and wireless energy management application. In this paper, we propose a proficient monitoring system for generating SOLAR power. The working mechanism monitors the power from the load side and sends to monitoring unit.

Each solar panel which is connected can be controlled by connecting and disconnecting as per the demand. Here we are implementing the IOT module with web browser application which monitor and detect the faulty solar panel. This IOT module and web browser in the system control and disconnect the fault solar panel from the network. By the time period of 2 seconds the data between the generation and utility unit will be sent continuously to the web page for further purpose. In experimental section we obtain the voltage of about 5v and 25v, in the sample manner the output voltage by the voltage sensor is varied from 0 to 5V. As per the result gained by the data, it is proven that the proposed mechanism is far better than the traditional systems

***Index Terms-*** Smart Grid, Wireless Sensor Network, Solar Power, IOT.

## I. INTRODUCTION

The energy distribution grid which we are using is followed for almost a century. As the global changes with technology advancement and consumer demands there is a need of effective grid system. According to the research by 2020 there will be a huge demand for an advanced grid which able to balance the demands. The major impact for the cause is increasing electricity cost, society, lifestyle and other strategies based on sustainability practices. The major drawback faced by the current electricity grid is lack of capability in processing the information and communication effectively. To overcome this issue a better smart grid is to be emerged.

Wireless Sensor Networks (WSNs) with smart grid will be a boon for intelligent devices. It is because of its factors like; innovative in information, communications, controlling and monitoring. These are all now becoming mandatory for the current application as per the lifestyle. The smart grid is not only initiated for power distribution but also essential for the industrial and residential customers. A perfect power distribution minimizes the cost by avoid investment on additional capacity. It enables industrial and residential customers to experience a minimum energy bill by means of automated shifting on flexible loads. These all can be achieved only by means of integrating the network on controlling the energy source.

Wireless Sensor Networks will be one of the dominant technology advancement in monitoring various applications in most of the scenarios. In other words, a smarter grid can achieve balancing measures during the power failures especially in situations like natural calamities. By increasing the distribution generation's capacity, it will increase the independency on grid. As a result there is valuable amount on emission of greenhouse gases with burning of fossil fuels can be reduced. These advantages carry no use in case of other faults like voltage rise, reverse power flow, etc. These distributed generations are modeled with electronic converters and inverters for achieving islanding mode in case of grid failure or in any power shutdowns. There are phases in sensing and control system such as Sensing phase, data communication phase and control phase. The Wireless Sensor Nodes (WSN) is implemented for enabling the sensing part more effective. Some of advantages of WSN are its tiny size, enhancement in electric power systems and its infrastructure is less nature. A combination of ultra-low power RF signals using WSN transceiver module is designed for data communications. Next a control system is applied in power electronic converters which act as an intermediary on transmitting power generation into the grid.

The IoT can provide remote data collection from connected devices, independent and secure connectivity between devices and device/sensor management. In the IoT concept, it would be worthwhile to deep dive in order to get familiar with the building blocks of IoT:

1. Sensors & Sensor technology – They will sniff a wide variety of information ranging from Location, Weather/Environment conditions, Grid parameters, Movement on assembly lines, Jet engine maintenance data to Health essentials of a patient.
2. IoT Gateways – IoT Gateways, as the name rightly suggests, are the gateways to internet for all the

things/devices that we want to interact with. Gateways help to bridge the internal network of sensor nodes with the external Internet or World Wide Web. They do this by collecting the data from sensor nodes & transmitting it to the internet infrastructure.

3. Cloud/server infrastructure & Big Data – The data transmitted through gateway is stored & processed securely within the cloud infrastructure using Big Data analytics engine. This processed data is then used to perform intelligent actions that make all our devices 'Smart Devices'.
4. End-user Mobile apps – The intuitive mobile apps will help end users to control & monitor their devices (ranging from room thermostat to jet engines & assembly lines) from remote locations. These apps push the important information on your hand-held devices & help to send commands to your Smart Devices!
5. IPv6 – IP addresses are the backbone to the entire IoT ecosystem. Internet is concerned about IP addresses only & not if you are a human or a toaster. With IPv4 we were running out of IP addresses, but with IPv6 (launched in 2012) we now have 3.4*10^38 IP addresses

Further in this paper the first section is deals with the need of solving the problem identified, the next section is about explaining the traditional methods. Then the third section deals with the proposed methodology followed by results and discussion. The final section is about conclusion and future work to be carried.

## II. LITERATURE SURVEY

Priya Sharma, Gitanjali Pandove [1] A review article on wireless sensor network in smart grid - In this paper the author explains problems and advantages of smart grid. Author also explain two-way communication system between the utilities and customers. By using the WSN as a communication technology, it will make the system cost and power effective. So WSN is a cost effective solution for monitoring, controlling, measurement and fault diagnosis in various domain of smart grid.

Jayanthi, Karthikeyan, Malukannan et al., smart grid management in renewable energy system using wireless sensor network, in this paper author explains proficient monitoring system for generating solar power and working mechanism monitors the power from the load side and sends to monitoring unit.

Priyanka Bhausaheb Deshmukh, Prof V.M.Joshi et al., proposed a system called IOT based Smart Grid to Remotely Monitor and
Control Renewable Energy Sources using VLSI, in this paper author explains Smart Grid architecture implemented with
the help of Web of Things. The goal of the Smart Grid architecture using Web of Things (WOT) is to provide the
reliable power supplies to the consumers by making maximum use of solar energy source. The Web of Things
comprise of a set of Web services provide on top of a number of Internet enabled Embedded devices. The Web browser
on any computer can act as an interface to the services provided by this Web of Things.

Soham Adhya[1], Dipak Saha[2], Abhijit Das[3], Joydip Jana[4], Hiranmay Saha et al., an IoT based smart solar photovoltaic remote monitoring and control unit, in this paper author explain implementation of new cost effective methodology based on IoT to remotely monitor a solar photovoltaic plant for performance evaluation. This will facilitate preventive maintenance, fault detection, historical analysis of the plant in addition to real time monitoring.

*Suman Patel et al.*, wireless sensor based smart grid management using photovoltaic system in this paper author explain smart demand responsive energy management system under new comprehensive field tests for wireless communication using mesh network based on AODV is proposed.

## III. PROPOSED SYSTEM ARCHITECTURE:

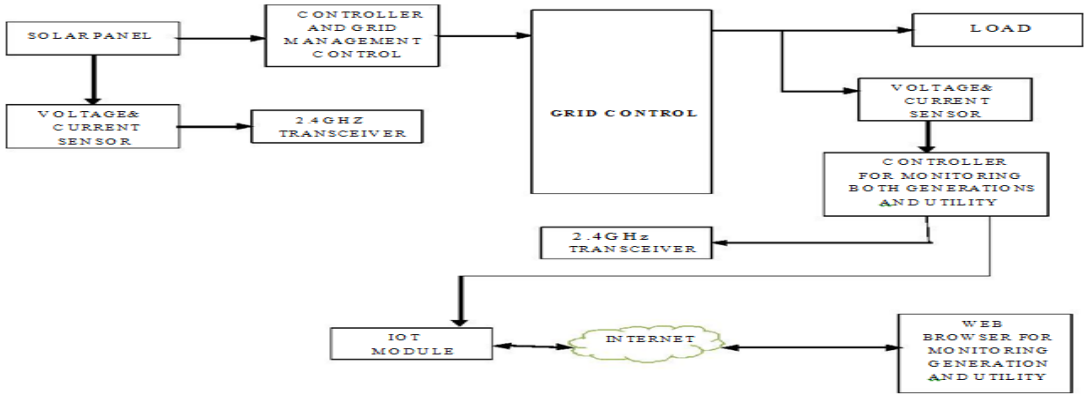


Fig.1: Proposed System Architecture

In our proposed system, we use advanced monitoring system for effectively utilizing the Solar electricity. In the present work, Solar panel main station is directly connected to the radio channel which is a transceiver of length 16 data channels thereby more data can be transferred. The main station can control the data transfers as IOT is directly connected to Main station. In the load side endlessly the power is monitored which are send to monitoring unit. The system is controlled by the solar panel with connecting and disconnecting as per the demands. An IOT module is inserted in the solar network which detects the fault solar panel and disconnects them from the entire network with the help of web browser application. As mentioned above, the entire monitoring is done at the IOT module and shared with the web browser. The web page will display the power output of the solar panel continuously with time between the generation and utility unit.

## IV. FLOWCHART

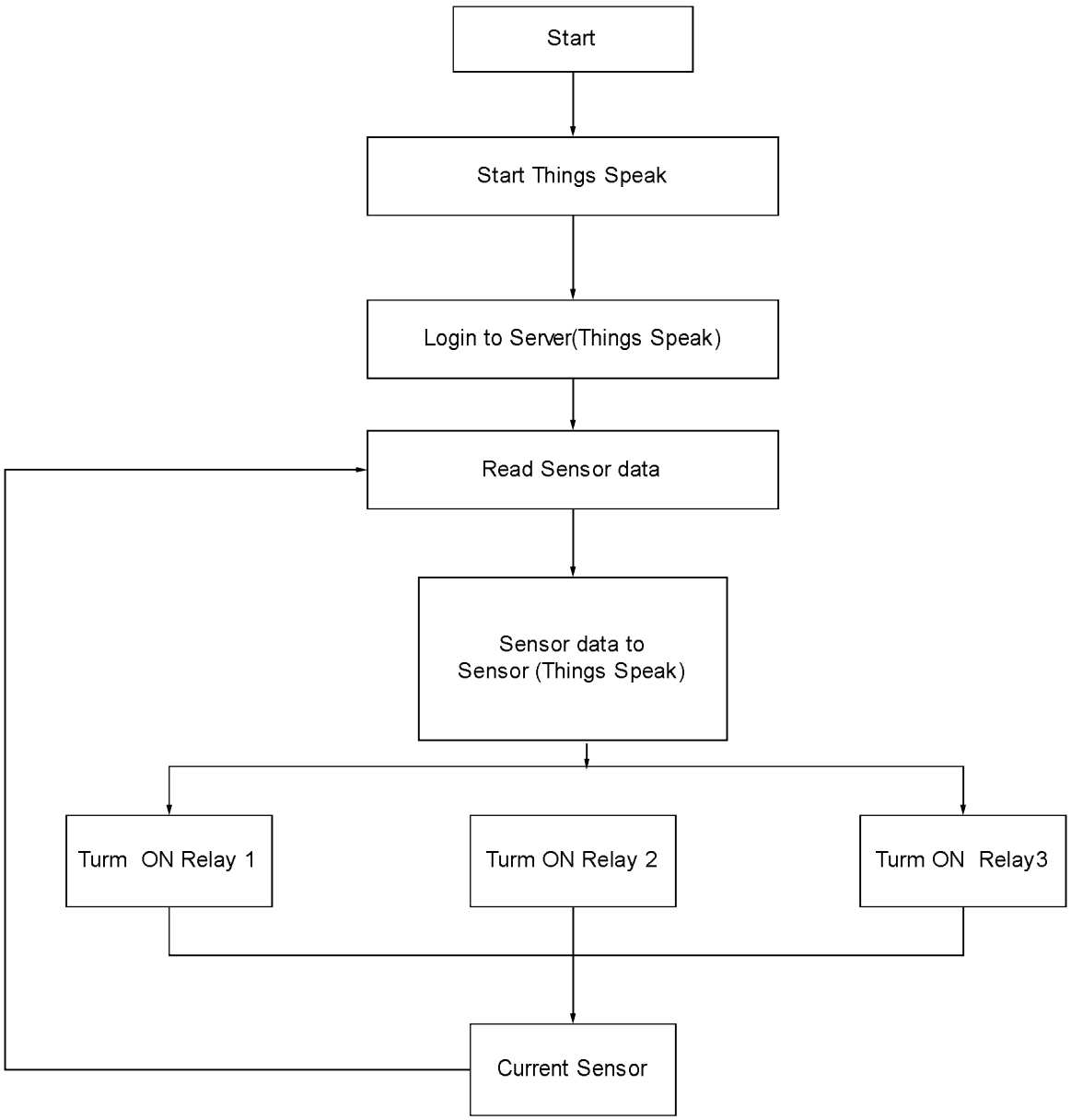


Fig.2: Flow Chart

## V. RESULT AND DISCUSSION

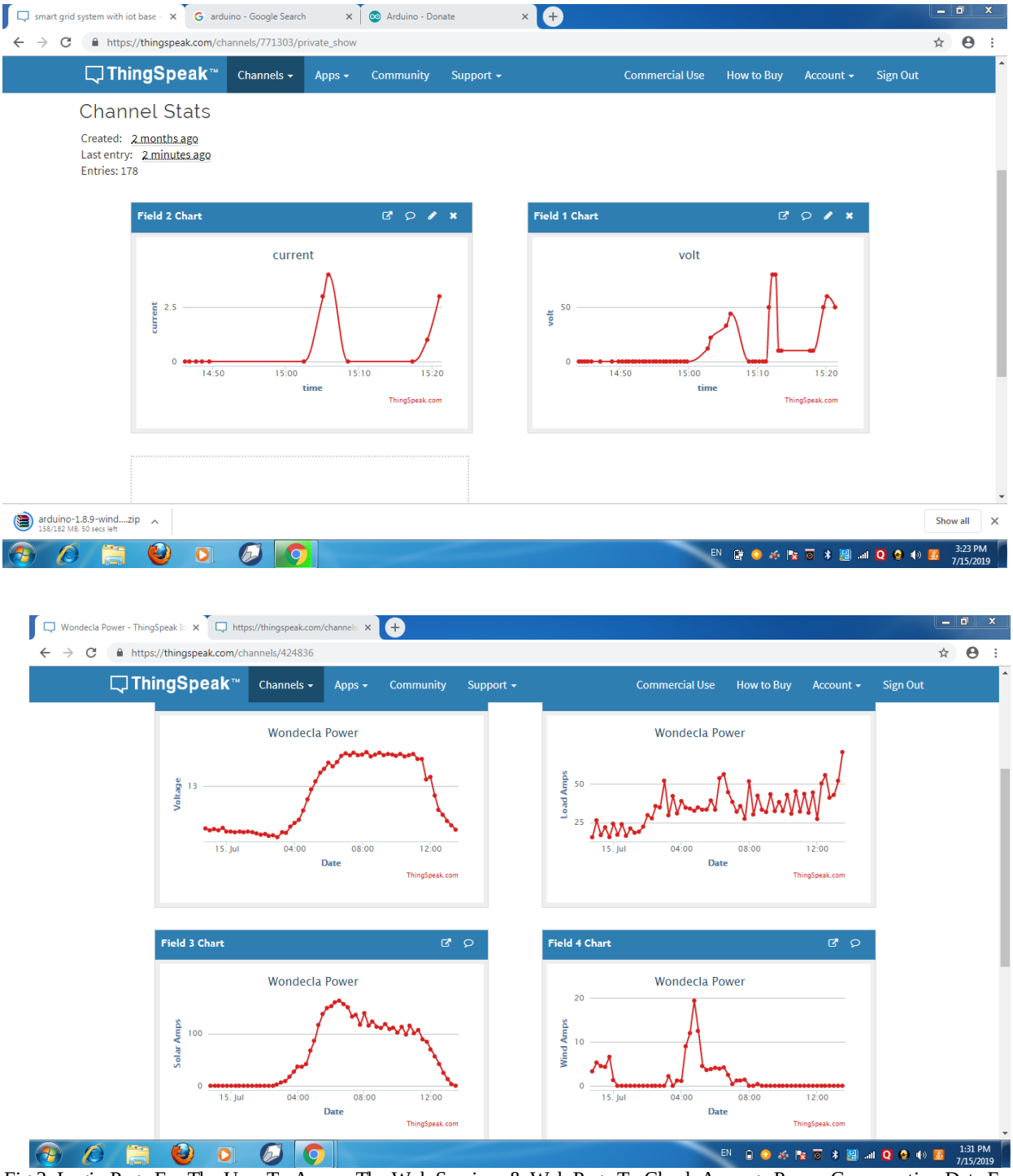


Fig.3: Login Page For The User To Access The Web Services & Web Page To Check Average Power Consumption Data For A Particular Time Span

In this graph show the important parameters of the solar panel such as, maximum voltage, maximum current, at the show them in every 10sec of the monitoring in the think speak.

Measured voltage = analog (0) (voltage sensor connected to pin) * (5.0/1024.0) *10;

Value 5.0 – denotes the voltage maximum

1024— analog to digital conversion 0 – 1023 (number pulses counted)

10 – Conversion factor (from 5v to 50v)
Total current of solar panel supplied to load is calculated using the following formula

Current Measurement

Amps = ((Analog input (1) (*5/1024))-2.5(offset value)

The important parameters of the solar panel such as, Peak power, maximum voltage, maximum current, open circuit and short circuit voltages are measured and tabulated in table.

| | |
|---|---|
| PMAX (WP) | 2W |
| MPP Voltage (V) | 13.1 V |
| MPP Current (mA) | 170 |
| Open Circuit Voltage (V) | 14 V |
| Short circuit Current (mA) | 200 |

The functionalities of the whole power monitoring system are given as a flow chart in Internet of things module is used for data collection and posting into the web browser through the Wi-Fi network. The data like voltage, current etc. collected from the solar panel is formulated to the data packets in microcontroller program. This program will send the data to the internet through IOT Wi-Fi Module. This module has an IP address obtained from the local network for internet connectivity. The user can call the IP address from the web browser. This browser will collect the data posted from the IOT module and displayed in the browser. The user can view the solar panel data from the web browser and make an analysis of using this data. Very soon in near future, the traditional grids of today will evolve into a robust, effective, environment-friendly and energy efficient system known as the Smart Grid.
It simplifies the work of the electricity board in tripping the supply to a particular customer in case of electricity theft etc. It helps the customer in knowing about the tariff variation. It enables transceiver interfaced with the Arduino section server as well as in the consumer side. Power consumed by the consumer is monitored by Arduino through think speck technology. Smart grid technologies are now providing information streams that are beginning to advance utility operations and business processes, while engaging residential, commercial, and industrial consumers in electricity management and even production.

## VI. CONCLUSION

Use of IoT for monitoring and controlling of a solar power plant is an important step as day by day renewable energy sources are getting integrated into utility grid. Thus automation and intellectualization of solar power plant monitoring and controlling will enhance future decision making process for large scale solar power plant and grid integration of such plants. IoT based remote monitoring will improve energy efficiency of the system by making use of low power consuming advanced wireless modules. IoT based remote monitoring will ensure comfortable plant monitoring and by controlling solar panels from web reduces human interaction with these type of systems as well as solar tracking will improve energy efficiency of the plant.

## VII. REFERANCE

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