ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 6, June 2017

IoT Enabled Smart Solar PV System

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ABSTRACT: There are two types of sources for electrical power generation. One is conventional and other is non-conventional. Today to generate most of electrical power conventional sources like coal, gas, nuclear power generators are used. Some of conventional source are polluting the environment to generate the electricity. And nuclear energy is not preferable because of its harmful radiation effect on the mankind. After few years conventional sources will not be sufficient enough to fulfill the energy requirements of the mankind. So some of the electrical power should be generated by non-conventional energy sources like solar, wind, etc. With the continuously reducing cost of PV power generation and further intensification of energy crisis, PV power generation technology obtains more and more application.

KEYWORDS: Solar energy, IOT.

I. INTRODUCTION

An intelligent solar PV system can use both electrical as well as solar energy to charge the system storage battery. This can further be used to generate electricity in the absence of either or both of energy sources. Usually electricity from solar panels is generated only during the day, with a peak production around midday. This electricity is fluctuating and not synchronized with the electric consumption of the household. To overcome this gap between what is produced and what is required during the absence of solar electricity production. It is necessary to store energy for later use and manage energy storage and consumption in an intelligent way. Final objective is to monitor the PV system via Internet of Things (IoT).

II. RELATED WORK

Solar power system is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories to set up a working system. A solar array of a typical residential PV system is rack-mounted on the roof, rather than integrated into the roof or facade of the building, as this is significantly more expensive. Utility-scale solar power stations are ground-mounted, with fixed tilted solar panels rather than using expensive tracking devices. The existing systems contain a fixed solar panel which is not capable of solar tracking.

For an inverter to be considered smart, it must have a digital architecture, bidirectional communication capability and robust software infrastructure. The system begins with reliable, rugged and efficient silicon-centric hardware, which can be controlled by a scalable software platform incorporating a sophisticated performance monitoring capability. A smart inverter must be adaptive and able to send and receive messages quickly, as well as share granular data with the owner, utility and other stakeholders. Such systems allow installers and service technicians to diagnose operational and maintenance issues — including predicting possible inverter or module problems — and remotely upgrade certain parameters in moments.

The objective is to develop a dual axis tracking system for rotating the solar panel in two different axes or use the existing one. MPPT mechanism is applied to improve the power gain by accurate tracking of the sun. An intelligent

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hybrid inverter or smart grid inverter is a trending generation of inverter for solar applications using renewable energy for home consumption, especially for solar photovoltaic installations. Electricity from solar panels is generated only during the day, with peak generation around midday. This electricity is fluctuating and not synchronized with the household's electricity consumption. To overcome this gap between what is produced and what is consumed during the evening when there is no solar electricity production, it is necessary to store energy for later use and manage energy storage and consumption in an intelligent hybrid (smart grid) inverter as shown in Fig. 1. Actual implemented system is shown in Fig. 2. with connectivity to internet for monitoring and analysis.

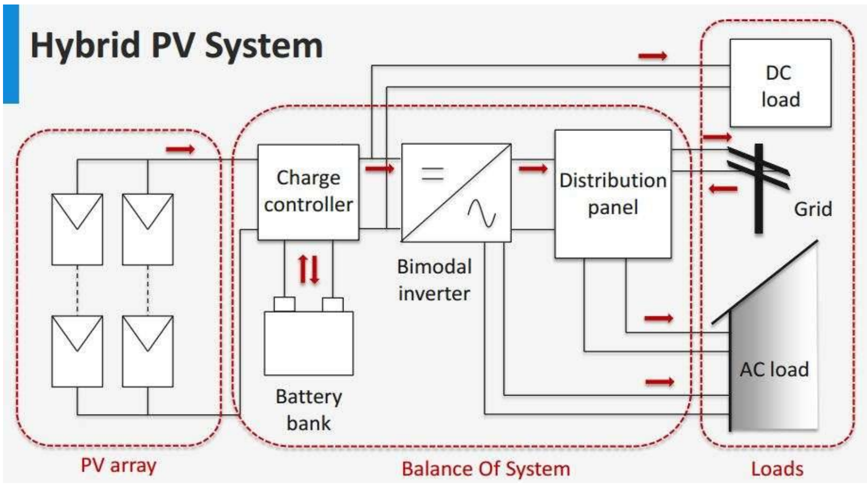

Fig.1. Block diagram of proposed system

Fig.2. Solar PV developed with Sun tracking

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In a nutshell, the functional flow adopted would be

- **Use in off grid mode** (without network) with the possibility of linking to a generator. The inverter must be connected to a battery bank and must have true off grid capabilities - not all Hybrid inverters are created equal or can be used in off grid applications.
- **Use in on-grid or grid-tie** (connected to the network) with the possibility of selling energy or excess energy. There is a need to have the norm compliance of protection and decoupling.
- **Use in hybrid mode** the inverter functions with a battery bank, but also connected to the grid. This dual functionality is the highlight of hybrid inverters that hence enable energy management (smart grid).
- **Use in Back-up mode**, or storage mode prevents blackouts by switching from on-grid mode to off-grid mode at the moment of electric outage, thereby eliminates network cuts.

Advantages

- Renewable energy source
- Reduces electricity bills
- Low maintenance cost
- Technology development

Disadvantages

- Weather dependent

Applications

- Single axis sun tracker can be used for large and medium scale power generation.
- It can also be used for power generation at remote places.
- It may be used as domestic backup power system.
- It can be used in solar street lighting system.
- It may be used in water treatment technologies and solar heating.
- It can be commercialized.

III. Design Considerations

- This system functions best in localities with less cloud cover.
- The capacity of the system is dependent on the maximum output power of the solar panels and the battery storage capacity.
- The parameter monitoring capabilities depend on the availability of internet connectivity.

IV. Simulation Results

Thingspeak API is used to store and retrieve data from sensors using the HTTP protocol over the Internet or via a Local Area Network. Thingspeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.

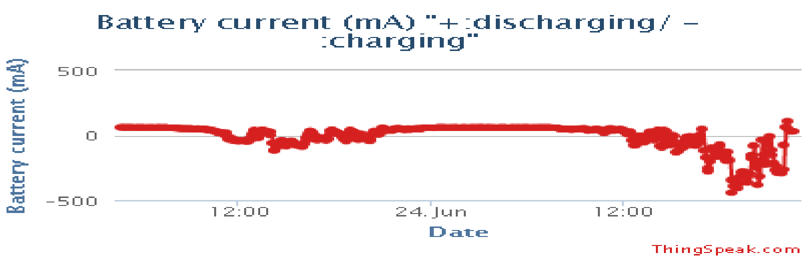

Fig.3. Battery current profile charging/discharging

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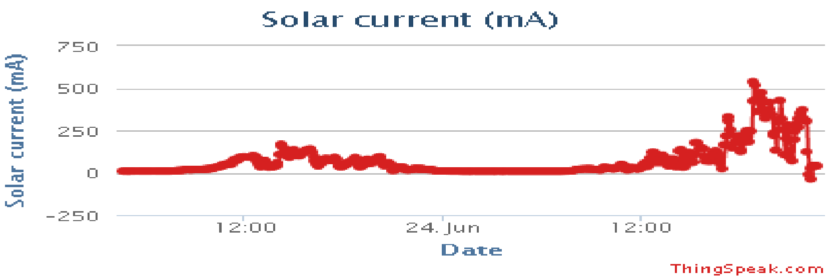

Fig.4. Solar current profile

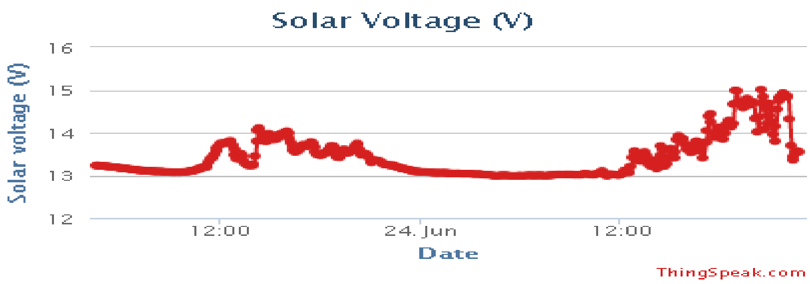

Fig.5. Solar Voltage profile

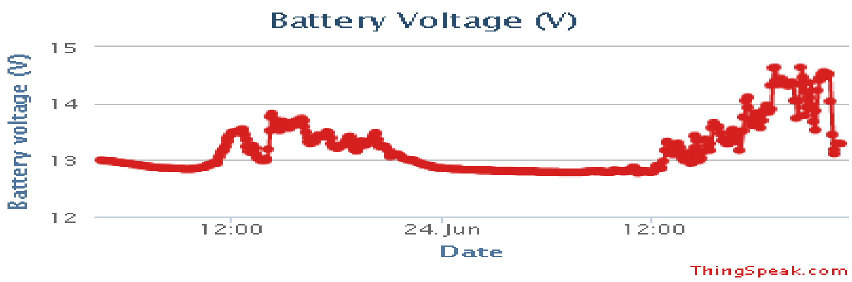

Fig.6. Battery Voltage profile

We can observe from Fig. 3. & Fig. 4. that the battery charges when the solar current is high and similarly the battery voltage increases as it gets charged. Since the solar panel is simultaneously powering the load and charging the battery we do not see a drop in the battery voltage as shown in Fig. 5. & Fig. 6.

V. CONCLUSION AND FUTURE SCOPE

We conclude that an intelligent hybrid solar PV system is a new generation of dedicated UPS which can use solar energy to charge the system storage battery and a given load. The stored energy can be used to generate electricity in the absence of either or both of the energy sources. Also the implementation of Internet OF Things (IOT) for supervising solar photovoltaic generation can greatly enhance the performance, monitoring and maintenance of the plant.

All the circuit topologies proposed in the present work is related to a single-phase inverter system. Thus, these topologies can be easily extended for the three-phase and high power solar PV based grid interactive inverter systems.

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