A Review on Maximum Power Point Tracking for Increasing Solar Photovoltaic Efficiency

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Abstract— The Maximum power point tracking (MPPT) is a more significant role in Solar Generation System. This paper presents a survey of different techniques used in the implementation of solar Photovoltaic Systems. The Energy Utilization Efficiency of a PV Standalone system can be significantly improved by using MPPT controllers. But the problem arises with selecting the proper MPPT as each MPPT has its own merits and demerits. This paper presents a comprehensive review of major MPPT techniques used for standalone and grid connected systems.

Keywords: Maximum peak power tracking, solar Photovoltaic Cells, Renewable Energy

I. INTRODUCTION

The energy has become a basic need for the human beings, enabling a better lifestyle. This has enabled the demand for energy to grow across the globe, amplifying the gap between supply and demand and increasing the cost of the energy. Especially in India there is a big gap between domestic supply and demand and the country depends heavily on imports for energy, which have increased the risk of price volatility and potential for energy disruptions. In addition to this the increasing energy consumption has increased carbon dioxide emissions, which have led to the global warming. One of the best solutions to address such a situation is to curb and reduce the energy consumption by taking appropriate energy efficiency improvement measures. Energy efficiency measures can reduce the energy requirements, dependence on imported energy and carbon dioxide emissions, without affecting the human quality of life. In addition to the environmental and energy security benefits the energy efficiency measures can bring additional benefits to the EU such as creating new jobs, tax generation, GDP growth, reducing current account deficit, etc. Such a potential of the EE is been well recognized by various stakeholders. However the current level of investment in this sector is minimal.

II. THEORY

A. *Pv* Cell

The solar cell is the basic unit of a PV system. An individual solar cell produces direct current and power typically between 1 and 2 W, hardly enough to power most applications. Solar Cell or Photovoltaic (PV) cell is a device that is made up of semiconductor materials such as silicon, gallium arsenide and cadmium telluride, etc. that converts sunlight directly into electricity. The voltage of a solar cell does not depend strongly on the solar irradiance but depends primarily on the cell temperature. PV modules can be designed to operate at different voltages by connecting solar cells in series. When solar cells absorb sunlight, free electrons and holes are created at positive/negative junctions. If the positive and negative junctions of solar cell are connected to

DC electrical equipment, current is delivered to operate the electrical equipment. Fig 1 Shows the Solar PV model of the system.
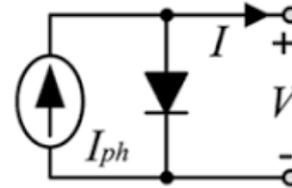

Fig. 1: Solar PV model of the system.

The efficiency of a solar cell is determined as the fraction of incident power which is converted to electricity and is defined as:

$$P_{max} = V_{OC} I_{SC} FF$$

$$\eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

where V_{oc} is the open-circuit voltage; where I_{sc} is the short-circuit current; and where FF is the fill factor where η is the efficiency.

III. LITERATURE REVIEW

Sunil Kumar Mahapatro in [4] authors have proposed the need for renewable energy sources is on the rise because of the acute energy crisis in the world today. Solar energy is a vital untapped resource in a tropical country like ours. The main hindrance for the penetration and reach of solar PV systems is their low efficiency and high capital cost. In this paper utilization of a buck-boost converter for control of photovoltaic power using MPPT control mechanism is presented. For the main aim of the project the boost converter is to be used along with a MPPT control mechanism. The MPPT is responsible for extracting the maximum possible power from the photovoltaic and feed it to the load via the buck-boost converter which steps up the voltage to required magnitude. The main aim will be to track the maximum power point of the photovoltaic module so that the maximum possible power can be extracted from the photovoltaic. In this thesis, we examine a schematic to extract maximum obtainable solar power from a PV module and use the energy for a DC application. This project investigates in detail the concept of MPPT which significantly increases the efficiency of the solar photovoltaic system.

Jancarle L. Santos et.al.In[1] this study of work deals with the design and experimental implementation of a MPP-tracker for photovoltaic systems, which is a high efficiency dc/dc boost converter operating in continuous conduction mode (CCM). The converter is able to draw maximum power from the PV panel for a given solar

radiation level and environment temperature by adjusting the duty cycle of the converter. Additionally, a passive non dissipative turn-on turn-off snubber is used, so that high efficiency and reduced electromagnetic interference (EMI) levels due to the soft switching operation can be obtained. The snubber improves the converter efficiency since the energy that would be dissipated during turning on and turning off is transferred to the load. The control technique, implemented with a single-chip microcontroller 80C51, is based on the perturbation and observation method, where the maximum power point is tracked with periodical calculation of the panel output power. Simulation and experimental results describe the performance of the proposed MPP-tracker.

Masoum, M.A.S. In [2] authors has analyzed Detailed theoretical and experimental analyses are presented for the comparison of two simple, fast and reliable maximum power-point tracking (MPPT) techniques for photovoltaic (PV) systems: the voltage-based (VMPPT) and the current-based (CMPPT) approaches. A microprocessor-controlled tracker capable of online voltage and current measurements and programmed with VMPPT and CMPPT algorithms is constructed. The load of the solar system is either a water pump or resistance. "Simulink" facilities are used for simulation and modeling of the novel trackers. The main advantage of this new MPPT, compared with present trackers, is the elimination of reference (dummy) cells which results in a more efficient, less expensive, and more reliable PV system.

Yeong-Chan Kuo In [3] authors has proposed a novel MPPT controller for a photovoltaic (PV) energy conversion system is presented. Using the slope of power versus voltage of a PV array, the proposed MPPT controller allows the conversion system to track the maximum power point very rapidly. As opposed to conventional two-stage designs, a single-stage configuration is implemented, resulting in size and weight reduction and increased efficiency. The proposed system acts as a solar generator on sunny days, in addition to working as an active power line conditioner on rainy days. Finally, computer simulations and experimental results demonstrate the superior performance of the proposed technique

Christopher John Lohmeier, M.S in [6] Described and designed the algorithm of Solar photovoltaic (PV) panels are a great source of renewable energy generation. The biggest problem with solar systems is relatively low efficiency and high cost. This work hopes to alleviate this problem by using novel power electronic converter and control designs. An electronic DC/DC converter, called "Quasi-Double-Boost DC/DC Converter," is designed for a Solar PV system. A MTTP algorithm is implemented through this converter. This algorithm allows the PV system to work at its highest efficiency. Different current sensing and sensorless technologies used with the converter for the MPPT algorithm are offered and tested. Design aspects of the system and components will be discussed. Results from simulations and experiments will be presented. These results will show that the proposed converter and MPPT control algorithm improves overall PV system efficiency without adding much additional cost.

Sunil Kumar Mahapatro [9] in formulated the need for renewable energy sources is on the rise because of the acute energy crisis in the world today. India plans to produce 20 Gigawatts Solar power by the year 2020, whereas we have only realized less than half a Gigawatt of our potential as of March 2010. Solar energy is a vital untapped resource in a tropical country like ours. The main hindrance for the penetration and reach of solar PV systems is their low efficiency and high capital cost. In this paper utilization of a buck-boost converter for control of photovoltaic power using MPPT control mechanism is presented. For the main aim of the project the boost converter is to be used along with a Maximum Power Point Tracking control mechanism. The MPPT is responsible for extracting the maximum possible power from the photovoltaic and feed it to the load via the buck-boost converter which steps up the voltage to required magnitude. The main aim will be to track the maximum power point of the photovoltaic module so that the maximum possible power can be extracted from the photovoltaic.

P.Sathya1, Dr.R.Natarajan [5] this paper presents the design and implementation of high performance closed loop Boost converter for solar powered HBLED lighting system. The proposed system consists of solar photovoltaic module, a closed loop boost converter and LED lighting module. The closed loop boost converter is used to convert a low level dc input voltage from solar PV module to a high level dc voltage required for the load. To regulate the output of the converter, closed loop voltage feedback technique is used. The feedback voltage is compared with a reference voltage and a control signal is generated and amplified. The amplified signal is fed to 555 Timer which in turn generates a PWM signal which controls the switching of MOSFET. Thus by switching of MOSFET it would try to keep output as constant. Initially the boost converter, timer circuit, amplifier circuit and LED light circuits are designed, simulated and finally implemented in printed circuit board. The simulation studies are carried out in MULTISIM. The experimental results for solar PV and boost converter obtained in both software and hardware are presented here.

V.C. Kotak1, Preti Tyagi [8] The DC/DC converters are Widely used in photovoltaic generating systems as an interface between the photovoltaic panel and the load, allowing the follow-up of the maximum power point (MPP).To extract the maximum power, you must adjust the load to match the current and voltage of the solar panel. The converter must be designed to be connected directly to the photovoltaic panel and perform operation to search the maximum power point (MPPT). DC/DC converters together with maximum power point tracking systems (MPPT) are used to avoid these losses.

Pui-Weng Chan, Syafrudin Masri [7] The main purpose of this paper is to introduce an approach to design a DC-DC boost converter with constant output voltage for grid connected photovoltaic application system. The boost converter is designed to step up a fluctuating solar panel voltage to a higher constant DC voltage. It uses voltage feedback to keep the output voltage constant. To do so,a microcontroller is used as the heart of the control system which it tracks and provides pulse-width-modulation signal to control power electronic device in boost converter. The boost converter will be able to direct couple with grid-tied inverter for grid connected photovoltaic system.Simulations

were performed to describe the proposed design. Experimental works were carried out with the designed boost converter which has a power rating of 100 W and 24 V output voltage operated in continuous conduction mode at 20 kHz switching frequency. The test results show that the proposed design exhibits a good performance

IV. CONCLUSION

In this review several MPPT methods have been surveyed for solar photovoltaic efficiency. The Different MPPT methods are discussed based on dynamic response, simulation, and efficiency and implementation consideration. The concluding discussion are several number of hybrid MPPT methods are included with their benefits. Further MPPT is discussed for specific PV systems.

REFERENCES

[1] Jancarle L. Santos et.al, "Maximum Power Point Tracker for PV Systems", World Climate & Energy Event, 1-5 December 2003, Rio de Janeiro, Brazil,pp 75-79.

[2] M.A.S. Masoum, H. Dehbonei, "Theoretical and Experimental analyses of Photovoltaic Systems with Voltage- and Current- based Maximum Power Point Tracker", IEEE Trans. On Energy Conversion, vol.17, no.4, pp.514-522, Dec.2002

[3] Yeong-Chau Kuo et.al. Novel maximum-power-point-tracking controller for photovoltaic energy conversion system, IEEE Transactions on Industrial Electronics (Volume:48 , Issue: 3), Page(s):594 - 601

[4] Sunil Kumar Mahapatro,MaximumPower Point Tracking (MPPT) Of Solar Cell Using Buck-Boost Converter, International Journal of Engineering Research & Technology, Vol.2 - Issue 5 (May - 2013) e-ISSN: 2278-0181

[5] P.Sathya1, Dr.R.Natarajan, "Design and Implementation of 12V/24V Closed loop Boost Converter for Solar Powered LED Lighting System" International Journal of Engineering and Technology, Vol5 , No.1, 2013, pp. 254- 264.

[6] Christopher John Lohmeier Highly Efficient Maximum Power Point Tracking Using a Quasi-Double-Boost DC/DC Converter for Photovoltaic Systems, 2015.

[7] Syafrudin Masri, Pui-Weng Chan, ―Development of a microcontroller-based boost converter for photovoltaic system‖, European Journal of Scientific Research ISSN 1450-216X Vol.41 No.1 (2014), pp.38-47

[8] V.C. Kotak, Preti Tyagi, "DC To DC Converter in Maximum Power Point Tracker", International journal of advanced Reserch in Electrical, Electronics and Instrumentation Engineeirng, 2015.

[9] Sunil Kumar Mahapatro, MPPT Based Solar PV System For 3-? Grid Connected IGBT Inverter System Using POWER-GUI Environment ,International journal of Engineeirng research and Technology, Vol.2 - Issue 4 (April - 2013).