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AN EFFICIENT ENERGY MANAGEMENT SYSTEM USING SOLAR ENERGY

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ABSTRACT

The need for an energy sources is on the rise as the world is facing energy crisis and global warming. Renewable energy harvested from the environment is an attractive option for providing green energy to homes. A high efficiency power management system for solar energy harvesting applications is proposed. Intensive efforts have been made recently in transforming the power grid into smart grid by means of incorporating extensive information and communication infrastructures. The concept Buck converter used in this paper increases the throughput of solar panel voltage. Smart energy meter, an added advantage of the proposed system provides a two way communication between the utility board and residential unit. This system is consisting of <i> solar panel for the generation of electricity from the sun. <ii> Battery is used to store the generated electricity. <iii> In any solar application battery life is important therefore Maximum Power Point Tracker (MPPT) algorithm is used for the maximum power extraction from the panel as to increase the battery life. <iv> inverter circuit is used to convert the DC power to AC power for the AC appliances.

Keywords – Power grid, smart grid, solar energy, buck converter, solar panel, MPPT (Maximum Power Point Tracking), PWM, Inverter

I. INTRODUCTION

An increasing Global warming, currently occurring on this 4.6 billion years old earth, is a very critical issue to be addressed by the modern society that has been enjoying economical growth by consumption of fossil energies Since the Industrial Revolution in Great Britain, much carbon dioxide (CO2) has been emitted as a result of the combustion of petroleum and coal. In the past 200 years, the carbon dioxide concentration in the atmosphere has increased by as much as 25%. Now the entire earth is, so to speak, situ three of the most prominent issues facing the world today are escalating climate change, energy security and meeting the increasing global demand for electrical energy generated from renewable sources. Renewable sources are also called Echo friendly technologies are very important due to their pollution free energy generation and having sustainable growth.

The electrical power grid is by nature is a complex adaptive system and it regards with significant amount of uncertainties [1]. The existing grid faces some sensitive problems which are major factors of concern. They can be specifically mentioned as follows:

1) limited delivery system. 2) High cost of power outage and power quality interruption. 3) Inefficiency at managing peak load. 4) Increase in global warming and hazardous emissions.

This negative impact of global warming and greenhouse effects is indeed a curse to the entire existence of life on earth. So for the sake of rescuing our earth it is mandatory to switch towards renewable energy sources. Since smart grid encapsulates this peculiar features of utilizing this renewable energy sources, smart grid integrate large amount of renewable generation in specific solar to meet our overwhelming electricity energy demands [2]. Smart grid introduces another worth mentioning feature say smart meter. Smart meter is a device that is connected to power distribution system which embeds a scheduling unit that helps in implementing shifting of workload [7], [9]. It also helps in receiving periodically the updated pricing information from various utility companies and the scheduling unit incorporated within it arranges the various household appliances for operation during different time intervals

II. LITERATURE SURVEY

Photovoltaic (PV) systems involve the direct conversion of sunlight into electricity with no intervening heat engine [7]. PV devices are solid state; therefore, they are rugged and simple in design and require very little maintenance. PV systems produce no emissions, are reliable, and require minimal maintenance to operate. They can produce electricity from microwatts to few megawatts. (Figure 1)

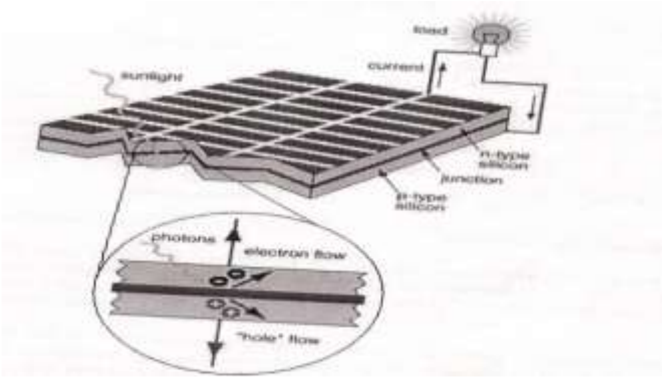

Fig1. Electricity generation by solar (PV) Module

The objective of this project is to develop a system which allows a user to switch between the mains and the battery. This allows the user to continuously monitor the usage of power and also to control it. This also affects the billing cost of the home/office because the load is switching between the mains and the solar power. So for the time the load is running on solar power the AC mains is not used and electricity is saved automatically. The switching between the mains and solar power depends on the battery capacity and the efficiency of the solar panel to charge the battery. The maximize the efficiency of the solar panel and battery the concept of MPPT i.e. Maximum Power Point Tracking is used in the proposed work. Also the user can continuously monitor the status of the load. The battery is also charged through the solar panel. Thus the electricity is saved for charging the battery.

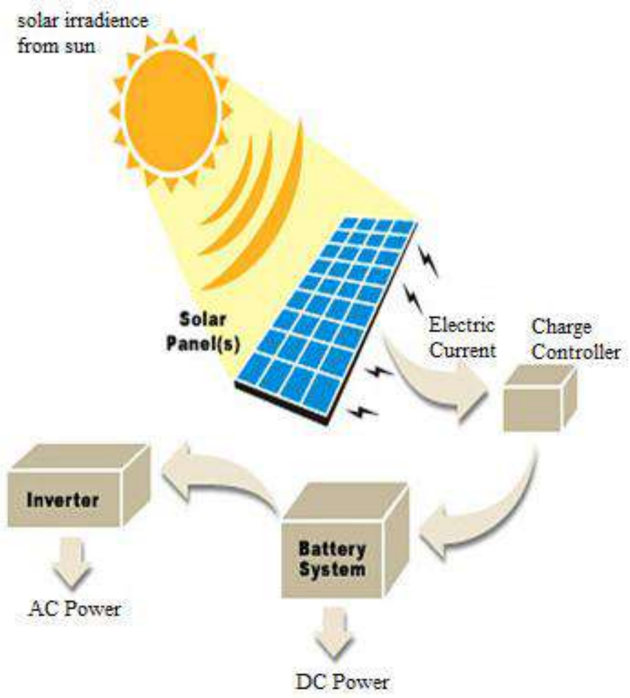

Fig2: Electricity generation using solar panel

III. SYSTEM OF ARCHITECTURE

Owing to uncertainties under the real time pricing environment this paper mainly focuses in minimizing the electricity expenses of customers through charging the battery efficiently from solar panels using Maximum Power Point Tracking (MPPT) Algorithm.

Any PV system mainly depends on the storage buffer. In some PV systems the battery accounts for more than 40% of the life cycle costs [1]. Battery life can be increased by avoiding deep discharging and over charging of the battery. To accomplish this task the maximum power point tracker (MPPT) algorithm is implemented. MPPT is the technique used to transfer the maximum possible power from solar panel to the load i.e. in our case battery. The essence of MPPT algorithm is buck convertor. Maximum power point is a product of maximum power point voltage and maximum power point current.

The figure3. Shows the block diagram of the proposed system. In this system the Atmega 328 microcontroller is used to provide the PWM signals which are necessary for the implementation of the MPPT algorithm. Atmega 328 controller is having six PWM channels. The shown system is independent of utility grid. The output of the solar panel is given to buck convertor.

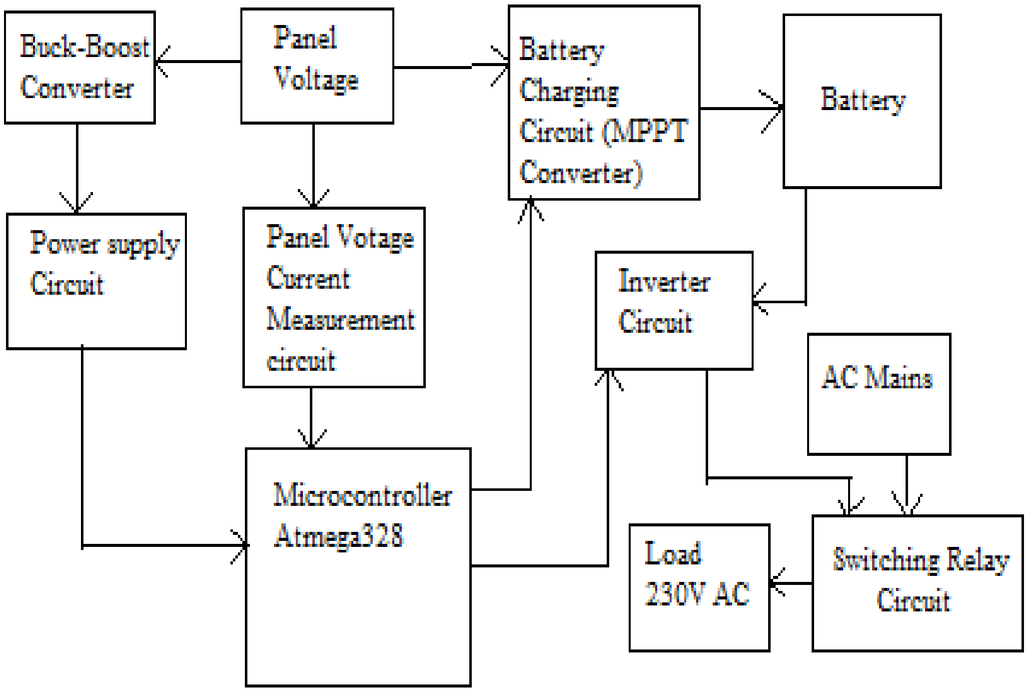

Fig3: System Block Diagram

A buck convertor is used to step down the voltage and step up the current. For the implementation of MPPT algorithm buck convertor is mandatory. The output of the buck convertor is given to the battery. For the MPPT algorithm controller gets the total four inputs. First two inputs are the voltage and the current of the solar panel and the rest of the inputs are the voltage and the current of the battery. According to the status of voltages and currents the controller generates the PWM signals. These generated PWM signals are given to the buck convertor for the controlled charging of the battery.[13]

The output of solar panel is also given to the buck-boost converter so as to generate a voltage of 12V. If the panel voltage is less than or greater than 12V the buck-boost converter will step up or step down the voltage accordingly. The converted voltage is then given to the power supply circuit to produce 5V for the microcontroller. Then the output of the power supply circuit i.e. 5V is given to the microcontroller. The PWM required for the inverter circuit is also provided by the microcontroller. The mains and inverter output is given to the switching relay circuit. This switching relay circuit is used to switch the load between mains and inverter. Thus the load is running on mains and solar power. Thus the billing cost is saved using the proposed system.[9]

Buck Convertor.

The basic configuration of buck convertor is shown in the following figure4. Buck convertor is simple DC-DC convertor.

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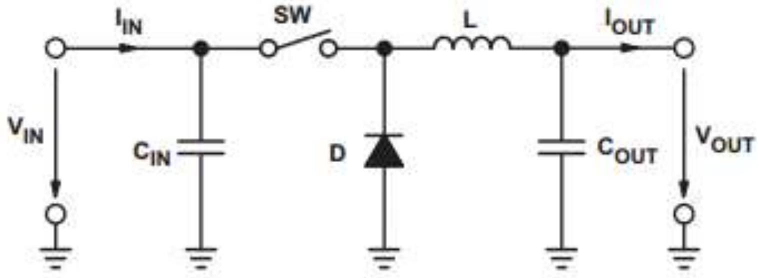

Fig4: Buck Convertor

When the power is taken into the consideration step down or buck convertors are widely used.

IV. RESULTS

Fig5: Result Display

The results which are shown in the following table are taken with the solar panel which is having rating of 10W. The MPPT algorithm which is implemented here almost gives the maximum power that is shown in the table.

Table -1: Results

Panel Voltage (V)	Panel current (amp)	Panel Power (watt)
17.43	0.48	8.41
17.37	0.41	7.12
17.41	0.53	9.3
17.01	0.46	7.8

16.98	0.3	5.09

Highlighted text value is where MPPT is achieved.

V. CONCLUSION

By implementing this proposed system we can reduce the electricity billing amount at a great extend using solar power. This system is independent of utility grid and it is a closed loop system. It uses maximum solar power to charge the battery. MPPT technique optimizes battery charging and increases the battery life. The system is based on solar energy it has great potential to reduce the pollution in the environment. It does not produce any hazardous gases to generate the electricity. In future this system will play an important role to save the billing amount as well as non renewable natural resources that are used to produce electricity.

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