International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

# Economical Power Generation Using PV Cell for Industrial and Domestic Applications

**D. Venu Satya Madhav[1], D. V. S. Prudhvi Raj[2], K. Durga Vara Prasad[3]**

[1, 2, 3]Pragati Engineering College, Surampalem, India

**Abstract:** ***Now-a-days the non-renewable sources are getting extinct so we should concentrate on developing energy based on renewable sources. So our project is mainly based on the power generation from solar energy (renewable source).The project consists of three sections likely Generation, Storing & Utilization. The generation is done through PV cells and stored with the help of batteries and utilized to both AC/DC loads[1]. Economical utilization on this power is done by giving away the excess power to the grid by taking the help of grid only in over load conditions. This whole controlling is done with the help of a Micro Controller. For DC loads the power is directly supplied from the PV cells/batteries and in case of AC load AC power is needed, so that an inverter is used to convert AC to DC power***

**Keywords:** PV Module; Solar Panel; cells, modules and arrays

## 1. Introduction

The continuous growth of for global energy demand and the environmental concern about the global warming, fossil fuel exhaustion and the need to reduce the carbon dioxide emission has to lead the exploration of renewable energy sources. As compared to other renewable energy sources photovoltaic energy has great advantages like cleanliness, no noise and very less maintenance. PV systems have been extensively used for low power electrical generation and have applications such as electrification for domestic applications, water pumping and air condition in rural and isolated areas. It is very difficult to establish a new utility system in rural areas because of cost and maintenance consideration. So DC micro grid can be directly used for rural requirements and solar energy can be utilized to generate power. The installed power can be increased by adding panels, which is one of the most attractive features of PV systems[1]. The low conversion efficiency of PV module and the variation of the output power due to changes in atmospheric conditions such as solar irradiation and temperature variation, requires specific control technique to ensure maximum power point operation in order to harvest maximum power from each module.

The 1950s was a period of great importance in the history of solar power. The first modern PV cell – able to convert enough solar radiation to electricity to power various devices – was developed by scientists at Bell Laboratories in 1954.

The original silicon solar cell had a 4% efficiency.1956 was another key point in the history of solar panels: research into using PV cells for satellites began[1-2].

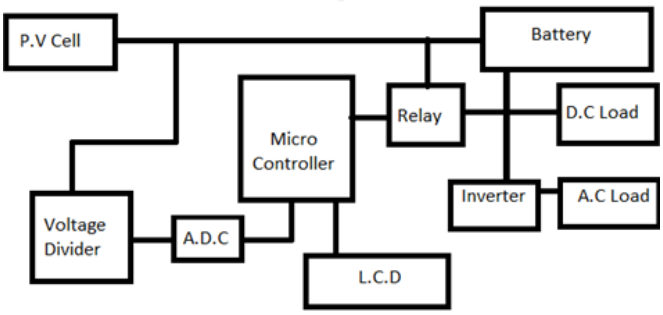


**Figure 1.1:** Block diagram

## 2. Photovoltaic Cells

Operating Principle: Photovoltaic cells are the major portions of greater sun based shows. Essentialness is made when photons of light from the sun strike a sun controlled cell and are a sorted inside the semiconductor material. This stimulates the semiconductor's electrons, conveying on the electrons to stream, and making a usable electric current [2]. The present streams in one heading and subsequently the force made is named direct present (DC) as will be elucidated in a word underneath. PN convergence (diode) is a farthest point between two differently doped semiconductor layers. One is a P-type layer (excess openings), and the second one is a N-type (plenitude electrons)[5]. At the breaking point between the P and the N district, there is an unconstrained electric field, which impacts the delivered electrons and openings and chooses the heading of the current.

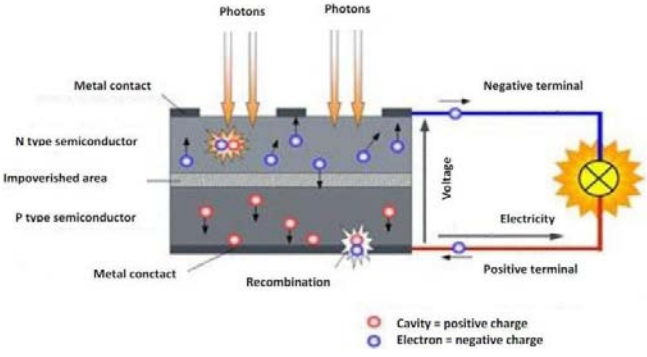

**Figure 2.1:** P-N junction

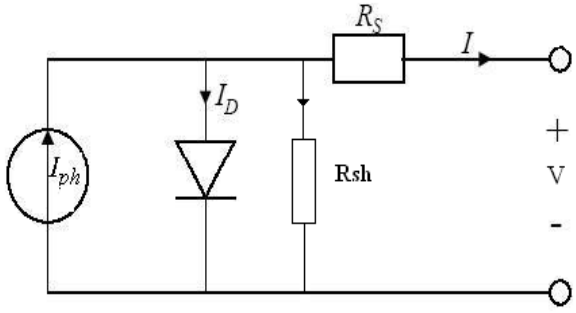


**Figure 2.2:** Equivalent circuit model of PV cell

Voltage output of a PV cell:

$$V_{pv} = \frac{ATK}{q} \ln\left[\frac{I_{ph} - I_{pv} - I_0}{I_0}\right] - I_{pv}R_s \quad (1)$$

Current output of a PV cell:

$$I_{pv} = N_p * I_{ph} - N_p * I_0 \left[\exp\left\{q * \frac{\left(V_{pv}\right) + \left(I_{pv}R_s\right)}{N_s AKT}\right\} - 1\right] \quad (2)$$

$$I_0 = I_{or}\left[\frac{T}{T_r}\right]^3 \exp\left[\frac{q * E_{go}}{AK}\left\{\frac{1}{T_r} - \frac{1}{T}\right\}\right] \quad (3)$$

PV array power can be calculated the following equation:

$$P_{pv} = V_{pv} * I_{ph} - V_{pv} * N_p * I_0 \left[\exp\left\{q * \frac{V_{pv} + I_{pv}R_s}{N_s AKT}\right\} - 1\right] \quad (4)$$

$V_{pv}$= output voltage of the pv cell(V)
$I_{pv}$= output current of a pv cell(A)
$N_s$ = number of modules connected in series
$N_p$ = number of modules connected in parallel
$I_o$ = PV cell saturation current (A)
$R$s=the series resistance of a PV cell
$A$ = B is an ideality factor=1.6
$K$ = Boltzmann constant=1.3805e-23Nm/K
$T$ is the cell temperature in Kelvin =298K
$Q$ is electron charge=1.6e-19Coulombs

**PV Module**

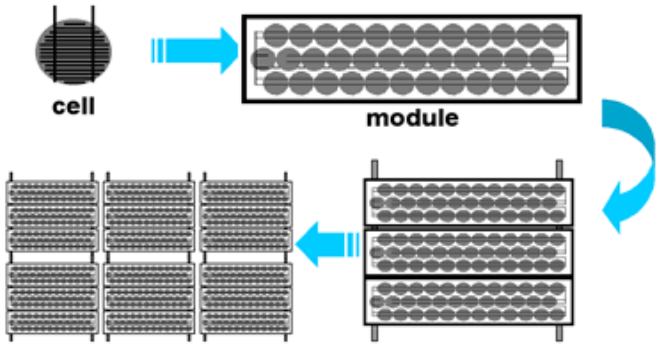


**Figure 2.3:** Photovoltaic cells, modules, panels and arrays

**Array**

An array is a structure that consists of a number of PV modules, mounted on the same plane with electrical connections to provide enough electrical power for a given application. Arrays range in power capacity from a few hundred watts to hundreds of kilowatts

**PV Array Parameters**

**Table 1**

| | |
|---|---|
| Typical peak power ($p_p$) | 60W |
| Voltage @ peak power ($v_{pp}$) | 17.1 V |
| Current @ peak power ($I_{pp}$) | 3.5 A |
| Guaranteed minimum peak power ($I_{pp}$) | 57W |
| Short-circuit current ($I_{sc}$) | 3.8A |
| Open- circuit voltage ($V_{oc}$) | 21.1V |
| Temperature co efficient of open- circuit | -(80+10)mv/c |

## 3. Problem Analysis and Solving

### 3.1 Problem Statement

The photovoltaic (PV) solar panels are semiconductor devices which convert the solar illumination power direct to electricity and their operational characteristics depend on incident sun light (isolation) level and the surface temperature that developed on the cell surface as the isolation, ambient temperature and current flow varies[3-5].

Energy conversion using solar (PV) panels is considered one of the best promising techniques in the field of renewable energy sources since photovoltaic (PV) panels uses free and non-exhaustible sunlight as the fuel[3-4].

So that maximum power can be extracted from PV panel. And the static losses can be removed. While coming to MPPT approaches there are many traditional ways which will be discussed below.

### 3.2 Traditional MPPT Approaches

The operating point at maximum power in systems based on PV modules depends on solar-radiation level, operating temperature and load current. So that's the reason to develop control algorithms in order to ensure that operating point achieves its optimal value[7-9].

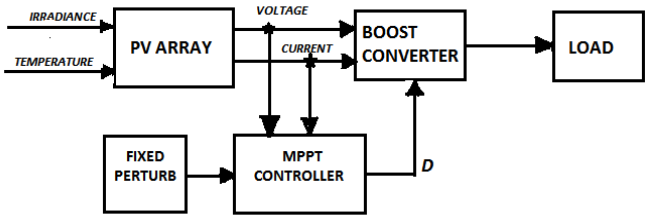


**Figure 3.1:** Block diagram

## 4. Hardware Implementation

As mentioned above that we extract power from solar panel by converting light energy into electrical energy which is pollution free. As our project is about utilizing power by our own generation and transmitting the excess of power to the grid or battery in over load conditions and utilize the current from grid or battery in low load conditions economically. So, this is our main objective.

- Solar Panel
- Rechargeable Battery
- Micro Controller
- Power Supply Circuit
- L.C.D (Liquid Cristal Display)
- A.D.C (Analog Digital Converter)
- Inverter
- Relay
- D.C Load
- A.C Load

**Solar panel**

Solar chargers convert light energy into DC current. Amount solar chargers are also known as solar panels. Solar panels are often connected to the electrical grid, whereas portable solar chargers as used off-the-grid (i.e. cars, boats, or RVs).Although portable solar chargers obtain energy from the sun only, they still can (depending on the technology) be used in low light (i.e. cloudy) applications. Portable solar charger are typically used for trickle charging,.

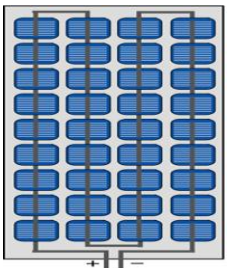

**Figure 4.1:** Solar panel

**Battery**

An electric battery is a device consisting of two or more electrochemical that converts stored chemical energy into electrical energy. Each cell has a positive terminal, or cathode, and a negative terminal, or anode. The terminal marked positive is at a higher electrical potential energy than is the terminal marked negative. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit

**LCD**

Finally the charging and discharging content of battery will be displayed in an LCD (16*2) by using an ADC0804 where the analog values will be converted into digital values and will be displayed in digital form.

**Inverter**

We have in our homes are specifically designed to run from AC power. Appliances that need DC but have to take power from AC outlets need an extra piece of equipment called a **rectifier**, typically built from electronic components called diodes, to convert from AC to DC.

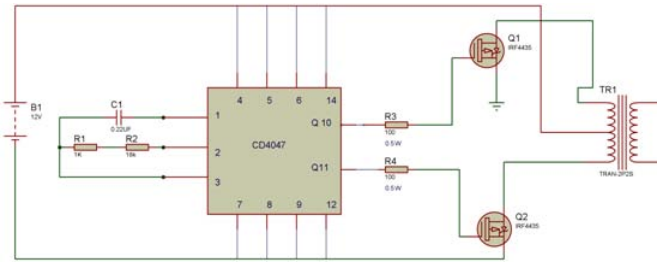


**Figure 4.2:** Inverter circuit

**D. C Load**

DC motors are broadly classified into three types.

- DC Series motor.
- DC Shunt motor.
- DC Compound motor.

DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion.

**Figure 4.3:** DC motor

The stator is the stationary outside part of a motor. The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole pieces. The magnetic field can alternatively be created by an electromagnet. In this case, a DC coil (field winding) is wound around a magnetic material that forms part of the stator. The rotor is the inner part which rotates. The rotor is composed of windings (called armature windings) which are connected to the external circuit through a mechanical commutator. Both stator and rotor are made of ferromagnetic materials. The two are separated by air-gap.

## 5. Working

The solar power is stored in the battery in D.C form by the P.V cells. D.C Load is supplied with power directly from

the battery source. To A.C load the power is supplied through Inverter. With the help of A.D.C the power flowing into load is sampled and sent to the Micro-Controller. Micro-Controller process this input from A.D.C does the switching between the power directly from the P.V Cells and the battery representing as the grid[4]. This whole process can be observed through the L.C.D connected.

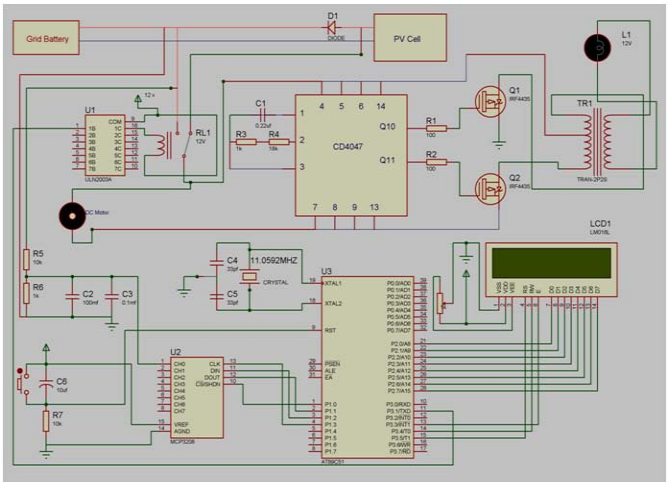


**Figure 5.1:** Schematic Diagram

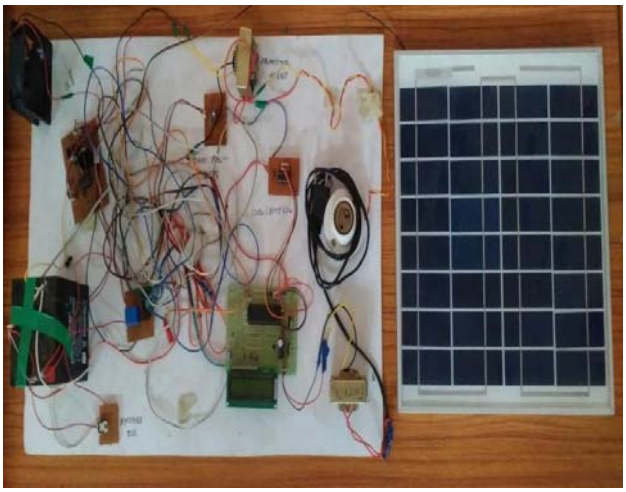

**Figure 5.2:** circuit connections of all components

## 6. Result

**Figure 6.1:** Solar panel of 60W

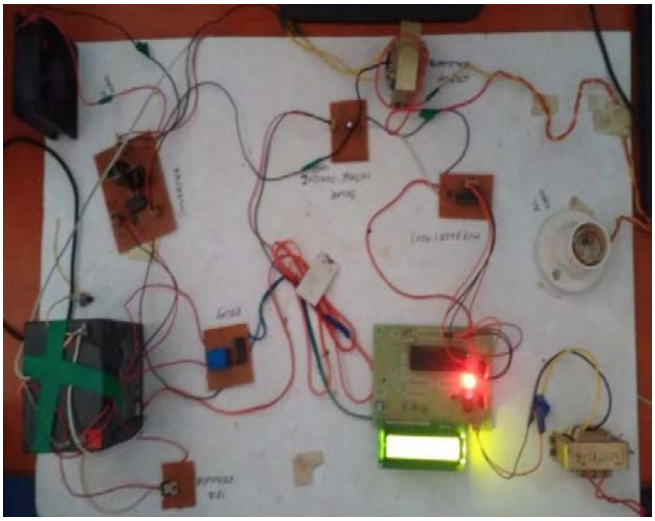

**Figure 6.2:** output voltage under non uniform irradiation

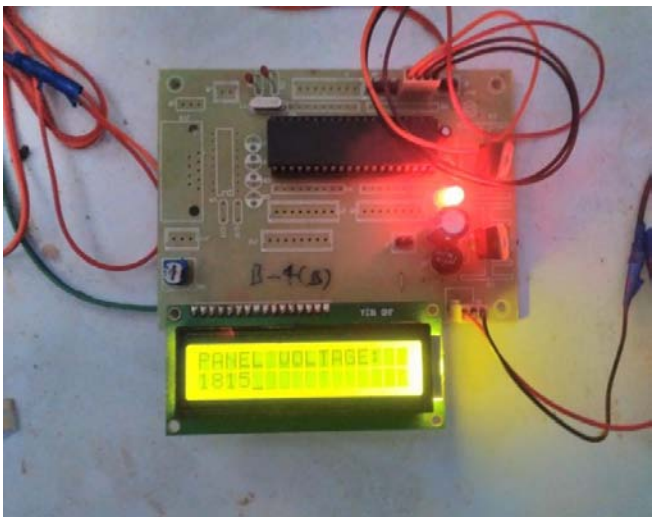


**Figure 6.3:** output voltage under uniform irradiation

## 7. Conclusion

Thus by using solar power we are reducing the use of non renewable source and decreased polluting the environment. We are economically producing our own power and also making money by selling excess power we produced. Using Grid power only in times of crisis we can reduce pollution and depleting the non renewable sources and decrease spend money on power to buy power from grid. And are able to use both A.C and D.C loads from a single system.

## References

[1] Y.-H. Liu, S.-C. Huang, J.-W. Huang, and W.-C. Liang, "A Particle Swarm Optimization-Based Maximum Power Point Tracking Algorithm for PV Systems Operating Under Partially Shaded Conditions," 2012

[2] I. Houssamo, F. Locment, and M. Sechilariu, "Maximum power tracking for photovoltaic power system: Development and experimental comparison of two algorithms," *Renewable energy,* vol. 35, pp. 2381-2387, 2010.

[3] T. Tafticht, K. Agbossou, M. Doumbia, and A. Chériti, "An improved maximum power point tracking method for photovoltaic systems," *Renewable Energy,* vol. 33, pp.

1508-1516, 2008

[4] K. Ishaque, Z. Salam, M. Amjad, and S. Mekhilef, "An improved particle swarm optimization (PSO)–Based MPPT for PV with reduced steady-state oscillation," *Power Electronics, IEEE Transactions on,* vol. 27, pp. 3627-3638, 2012.

[5] Y. Liu, D. Xia, and Z. He, "MPPT of a PV system based on the particle swarm optimization," in *Electric Utility Deregulation and Restructuring and Power Technologies (DRPT), 2011 4th International Conference on*, 2011, pp. 1094-1096.

[6] M. Drif, P. Perez, J. Aguilera, and J. Aguilar, "A new estimation method of irradiance on a partially shaded PV generator in grid-connected photovoltaic systems," *Renewable Energy,* vol. 33, pp. 2048-2056, 2008.

[7] N. A. Ahmed and M. Miyatake, "A novel maximum power point tracking for photovoltaic applications under partially shaded insolation conditions, "*Electric power systems research,Vol. 78,pp 777-784,2008.*

[8] T. L. Nguyen and K.-S. Low, "A global maximum power point tracking scheme employing DIRECT search algorithm for photovoltaic systems," *Industrial Electronics, IEEE Transactions on,* vol. 57, pp. 3456-3467, 2010

[9] K. Ishaque and Z. Salam, "A deterministic particle swarm optimization maximum power point tracker for photovoltaic system under partial shading condition," *Industrial Electronics, IEEE Transactions on,* vol. 60, pp. 3195-3206, 2013.