International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-3 Issue-1, June 2013

A Review on Solar PV Cell

Naresh Kumar Malik, Jasvir Singh, Rajiv Kumar, Neelam Rathi

***Abstract*— Photovoltaic cells provide an additional method of acquiring energy, converting sunlight directly into electricity through the use of semiconductors. Effective photovoltaic implementation is reviewed, focusing on semiconductor properties and overall photovoltaic system configuration.[1]**

***Index Terms*— energy conversion efficiency, photovoltaic, PV,solar cell.**

I. INTRODUCTION

Solar Cells (Photovoltaic Cells) are devices that convert solar energy to electrical energy using the field of technology known as photovoltaic's, hence the term photovoltaic (PV) cells. Such cells are made of semiconductor materials such as silicon, whose property is to knock electrons loose when they absorb energy, in this case, solar energy. The PV cells also have one or more electric fields whose purpose is to force the loose electrons in one direction, similar to how a diode functions, hence the formation of a current. This current can then be used externally using metal contacts at the top and bottom of the PV cell as can be seen in the figure below.[2]

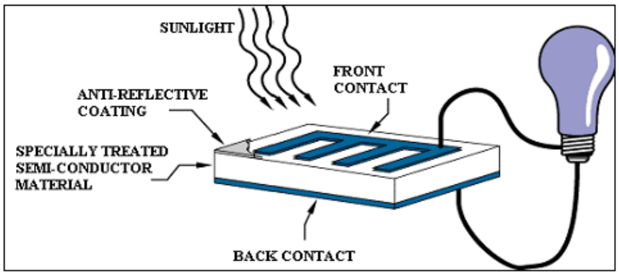


Figure :1 Basic components that make-up a PV cell [2].

II. HOW DOES A PHOTOVOLTAIC CELL WORK

Solar Cell Materials We focus on crystalline silicon solar cells because:

- They account for over 95% of the world market.
- Mostly of this is either multi-or mono-crystalline silicon. (as opposed to amorphous).[3]

A PV Cell, in circuital terms, can be modeled as a diode connected in series to a constant current source and in series to a resistance, known as the shunt resistance. However, for the sake of providing ideal simulation results, a 12V voltage source is implemented instead of this circuital design.
There are six properties that describe the behavior of light shining on a PV cell as illustrated in figure 2 [2].
I. Reflection and absorption at top contact;
ii. Reflection at cell surface;
iii. Desired absorption;
iv. Reflection from rear out of cell- absorbed light only;
v. Absorption after reflection;
vi. Absorption in rear contact;

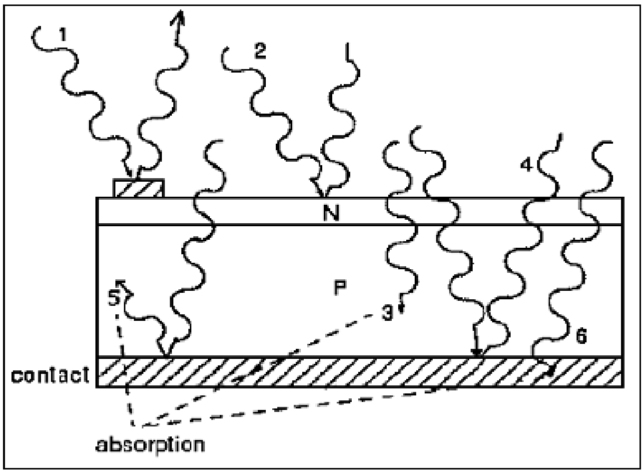


Figure 2: Behavior of light shining on a PV cell. [2]

In a practical system, one PV cell will not be able to provide sufficient energy. Thus, several cells are grouped together to form a PV module, and several modules are grouped together to form a PV array [2]. This combination of cells is what allows for a larger percentage of solar power to be absorbed due to a larger area of PV cells, and thus more current and voltage to be produced at the output. The solar PV array or module used has to be carefully designed to produce the right amount of power to charge the battery and also has to be designed to adhere to the charging characteristics of the battery as much as possible so as to minimize losses. Below epitomizes the formation of the PV module and array from the PV cell.

Manuscript published on 30 June 2013.
*Correspondence Author(s)
Naresh Kumar malik, Department of electrical engineering, P.T.U./B.G.I.E.T.Sangrur,Kaithal,India.
Jasvir Singh, Department of electrical engineering, P.T.U./B.G.I.E.T.Sangrur,Sangrur,India.
Rajiv Kumar, Department of electrical and electronics engineering, K.U.K.,/ HCTM Kaithal,Karnal,India.
Neelam, Department of electrical and electronics engineering, K.U.K.,/ HCTM Kaithal,Kaithal,India.

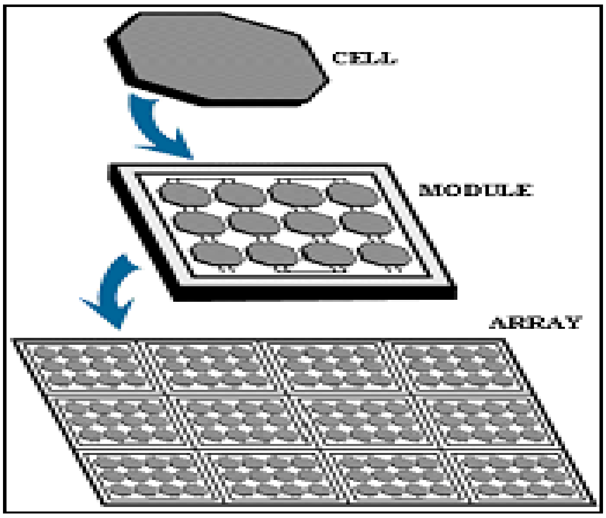


Figure 3: PV module and array formation from PV cells

A solar cell can be modeled as a current source which is parallel to a diode and an equivalent resistance. The equivalent resistance is comprised of a shunt (Rsh) and Series resistance(Rser). The series resistance factors in all the losses due to the resistive semiconductor material that the cell is made of, the resistance of the contacts, and other series losses. The shunt resistance is due to localized shorts in the silicon wafer that is the primary material of the cell.[2]

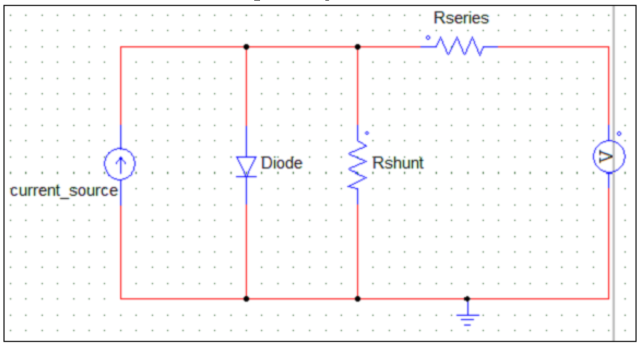


Figure 4: General circuit representation of a solar cell.

Generally, the series resistance is very small, and the shunt resistance is very large, making these losses almost negligible. Upon observation of the IV characteristics of a commercial solar panel such as the SQ150, it can be seen that changes in irradiance bring about significant changes in the panel short circuit current but barely affect the open circuit voltage. In effect, the short circuit current is approximately proportional to the irradiance. proposes that the current source used in the solar cell model be one that is dependent on a voltage; this voltage in turn is representative of the irradiance condition. Thus, the cell's characteristics can be made to vary with irradiance in a way that mimics the variations in the IV profile of a practical solar cell. A solar panel can be constructed out of series and parallel connections of the solar cell model given above. But, keeping in mind that the objective of the modeling process was to simply obtain a system whose IV characteristics are identical to that of a solar panel, another method was used: It was found that the open circuit voltage of the solar cell model is roughly proportional to the number of series-connected diodes that are in parallel to the short-circuit current source. Thus, by adding more diodes and increasing the short-circuit current, the characteristics of the solar cell become more and more like that of a panel. A photovoltaic panel is constructed out of several cells in series and parallel combinations. This allows a panel to output an utilizable voltage and current. The figure below illustrates the typical Current-Voltage (I-V) characteristics of a PV panel.

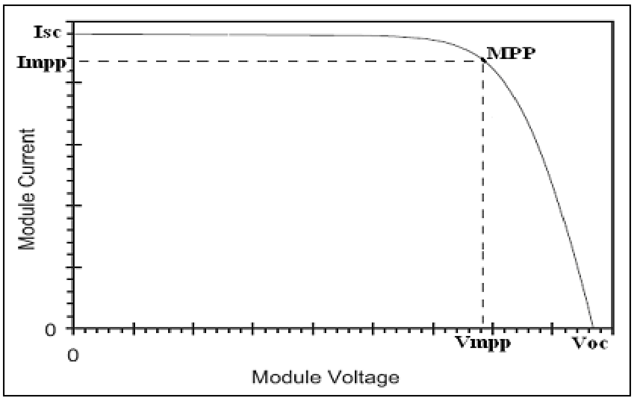


Figure 5: I-V characteristics of a PV panel

The curve shows how the current supplied by a PV panel varies with its voltage. The point of maximum power occurs at the knee of the curve and is called the maximum power point (MPP). The maximum power is given by

Pmpp = Vmpp x Impp

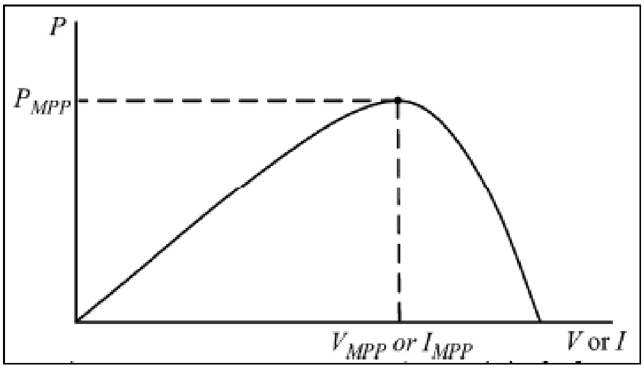


Figure 6: PV output power characteristics

In order for the PV panel to supply maximum power, it should supply a load of resistance (Rmpp):

Rmpp = Vmpp / Impp

If the load resistance as seen by the panel is below this value, the bias point would move to the left of the MPP, and to the right if the resistance is above this value.

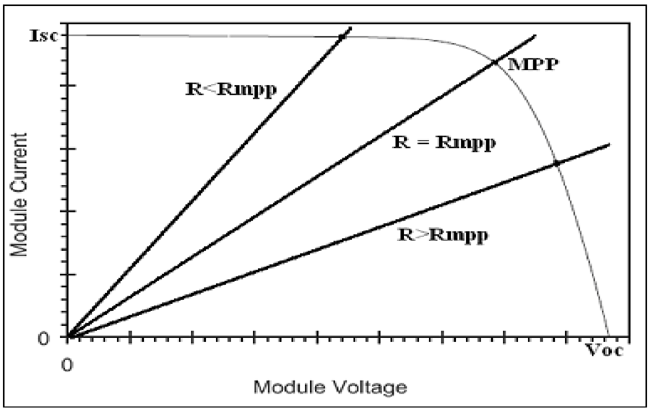


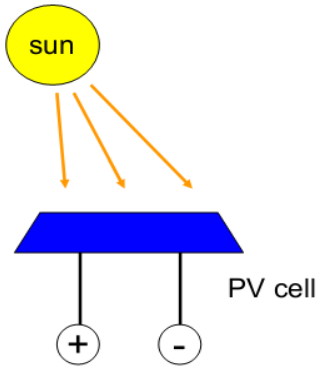
Figure 7: Bias points for various load resistances

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

III. PHOTOVOLTAIC'S: FUNDAMENTAL ATTRACTIONS AND DRAWBACKS

Photovoltaic's (PV): attractions:

- Converts sunlight directly to electricity.
- Sunlight is the most abundant renewable resource (175 PW).
- Electricity is a very versatile form of energy.
- No moving parts, long lifetime (>20 years).

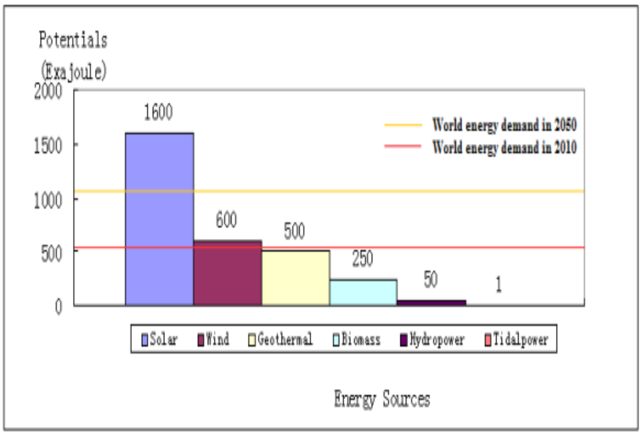


Photovoltaic's: drawbacks:

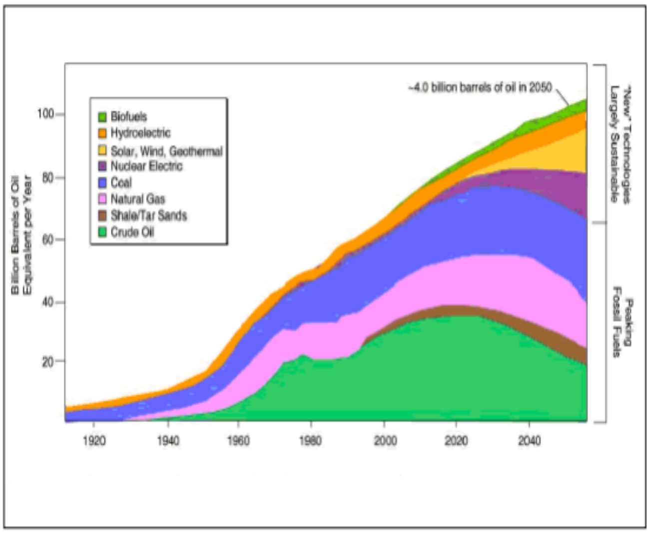
- Sunlight is very spread out (<1 kW/m2)
- It is irregular and somewhat unpredictable
- Electricity is difficult to store
- So far PV cells are expensive compared to other means of power generation.[3]

IV. WHY SOLAR ENERGY IS ONE OF THE KEY SOLUTIONS TO WORLD ENERGY DEMAND

The sun is the most plentiful energy source for the earth. All wind, fossil fuel, hydro and biomass energy have their origins in sunlight. Solar energy falls on the surface of the earth at a rate of 120 petawatts, (1 petawatt $=10^{15}$watt). This means all the solar energy received from the sun in one days can satisfied the whole world's demand for more than 20 years. We are able to calculate the potential for each renewable energy source based on today's technology. Future advances in technology will lead to higher potential for each energy source. However, the worldwide demand for energy is expected to keep increasing at 5 percent each year .olar energy is the only choice that can satisfy such a huge and steadily increasing demand. [4]



The Potential For Renewable energy source(Base on today technology level)[4]



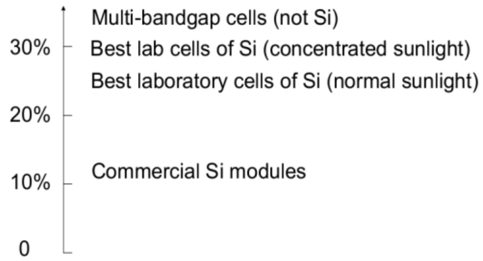
World Energy Demand and Forecast[4]

There are several applications for solar energy, for instance: electricity generation, photochemical, solar propulsion, solar desalination, and room temperate control. The collection of solar energy and its transfer to electricity energy will have wide application and deep impact on our society, so it has attracted the attention of the researchers. Electricity is high grade energy. This means it can be easily transferred into other forms like mechanical energy or heat. If we are able to generate economic and plentiful electricity energy, together with the easy transportation electricity energy transmission, the electric power will increase its shares in demand sectors dramatically.[4]

Limitations to efficiency:

- Sunlight contains a spectrum of photons of varying energy E
  –If E<band gap then the photon is useless
  –If E>band gap, then the excess energy becomes heat
- Optical effects: reflections, incomplete absorption, shading by contacts ..
- Recombination

Efficiencies achieved:



V. CONCLUSION

PV cells are a proven environmentally benign power source whose attractive characteristics will continue to further photovoltaic research. Because current PV systems are still highly inefficient and uncommon, they are not yet cost competitive with fossil fuel-based generators and are only regularly used where there is no nearby power source.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Photovoltaic advancements in the fields of thin film and nanocrystalline materials will continue to flourish and soon increase PV efficiency to over 50%. As efficiency increases, PV technology will attract a greater number of people, resulting in reduced cost. Because the sun delivers ten thousand times more energy than people currently consume, photovoltaic improvements will one day replace environmentally unfriendly power plants with a proven and clean energy source.[1]

- Photovoltaic (PV) cells convert sunlight directly into electricity
- They are made of doped semiconductor arranged to give a p-n junction
- The junction creates an electric field
- Light generates electrons and holes in the semiconductor
- These are separated by the field
- A current is thereby induced when the PV cell is connected in a circuit.

ACKNOWLEDGMENT

The authors would like to thank ASST. Prof. Jasvir Singh B.G.I.E.T. Sangrur, Punjab technical university, jallandhar,India. contribution to this paper.[5]

REFERENCES

1. Toub, “Department of Electrical and Computer Engineering, University of Rochester, Rochester New York 14627.
2. TABREZ MANSOORALI DAYA, “DEVELOPING THE NEXT GENERATION OF SOLAR LANTERN”. The University of Nottingham.
3. Philip Davies,“ Global warming and renewable energy,” philip.davies@warwick.ac.uk.
4. Yinghao Chu, Research Associate, “Global Energy Network Institute (GENI)),” *August 2011*. charlie0586@address.com
5. kinal kachhiya,Makarand lokhande and mukesh patle “MATLAB/Simulink Model of Solar PV Module and MPPT Algorithm” national conference on recent trends in engineering and technology.
6. I. H. Altas1,* and A.M. Sharaf2 “ A Photovoltaic Array Simulation Model for Matlab-Simulink GUI Environment” 2007 IEEE.
7. Huan-Liang Tsai, Ci-Siang Tu, and Yi-Jie Su, “Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK” Proceedings of the World Congress on Engineering and Computer Science 2008, October 22 - 24, 2008, San Francisco, USA.

AUTHOR PROFILE

Naresh Kumar is Lecturer in HCTM Technical Campus kaithal (Haryana).He is persuing M.tech. from P.T.U. Jallandher. He has received his B.tech. degree in electrical and electronics engineering in 2008, polytechnic diploma in 2005 and I.T.I. diploma in Lineman in 2002. His research focuses on energy management. His current research areas are modeling of solar pv cell.

Jasvir Singh is Assistant professor in B.G.I.E.T. Sangrur (Punjab).He has received his M.tech. Degree from Thapar University Patiala in 2010 . He has received his B.tech. Degree in electrical engineering in 2007 from P.T.U. Jallandher. His current research areas are Modeling of Power plants in MatLab which are based on non conventional sources of energy.

Rajiv Kumar is Assistant professor in HCTM Technical Campus Kaithal (Haryana).He has received his M.tech. Degree from M.D.U. Rohtak. He has received his B.tech. Degree in electrical and electronics engineering in 2008 kurukshetra university kurukshetra, polytechnic diploma in 2005. His current research areas are energy improvement using TCR and passive filter

Neelam Rathi is Assistant professor in HCTM Technical Campus kaithal (Haryana).She has obtained M.tech. from M.D.U. Rohtak. She is B.tech. in Electrical and Electronics from Kurukshetra University Her area of interest are power electronics ,linear integrated circuits.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)