Review on Solar Photovoltaic Cells

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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].

Key words—Energy conversion efficiency, photovoltaic, PV, solar cell.

I. INTRODUCTION

The development of new energy sources is continuously enhanced because of the critical situation of the chemical Industrial fuels such as oil, gas and others .Thus, the renewable energy sources have become a more important Contributor to the total energy consumed in the world. In fact, the demand for solar energy has increased by 20% to 25% over the past 20 years. The market for PV systems is growing worldwide. In fact, nowadays, solar PV provides around 4800 GW. Between 2004 and 2009, grid connected PV capacity reached 21 GW and was increasing at an annual average rate of 60% [2]. In order to get benefit from the application of PV systems, research activities are being conducted in an attempt to gain further improvement in their cost, efficiency and reliability. With no pollutant emission, Photovoltaic cells convert sunlight directly to electricity. They are basically made up of a PN junction. Figure 1 shows the photocurrent generation principle of PV cells. In fact, when sunlight hits the cell, the photons are absorbed by the semiconductor atoms, freeing electrons from the negative layer. This free electron finds its path through an external circuit toward the positive layer resulting in an electric current from the positive layer to the negative one.

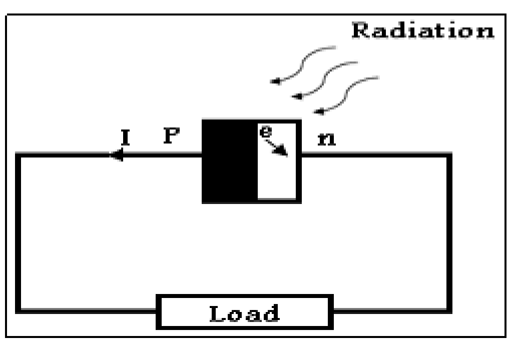


Fig.1 Photocurrent generation principle.

Typically, a PV cell generates a voltage around 0.5 to 0.8 volts depending on the semiconductor and the built-up Technology. This voltage is low enough as it cannot be of use. Therefore, to get benefit from this technology, tens of

PV cells (involving 36 to 72 cells) are connected in series to form a PV module. These modules can be interconnected in series and/or parallel to form a PV panel. In case these modules are connected in series, their voltages are added with the same current. Nevertheless, when they are connected in parallel, their currents are added while the voltage is the same. Three major families of PV cells are monocrystalline technology, polycrystalline technology and thin film technologies. The monocrystalline and polycrystalline technologies are based on microelectronic manufacturing technology and their efficiency is in general between 10% and 15% for monocrystalline and between 9% and 12% for polycrystalline. For thin film cells, the efficiency is 10% for a-Si, 12% for CuInSe2 and 9% for CdTe. Thus, the monocrystalline cell that has the highest efficiency[3].

II. PRINCIPLES OF OPERATION SOLAR PHOTOVOLTAICS

The solar energy can be directly converted into electrical energy by means of photovoltaic effect, i.e. conversion of light into electricity. Generation of an electromotive force due to absorption of ionizing radiation is known as photovoltaic effect. The energy conversion devices which are used to convert sunlight to electricity by use of the photovoltaic effect are called solar cells. Photo voltaic energy conversion is one of the most popular nonconventional Energy source. The photovoltaic cell offers an existing potential for capturing solar energy in a way that will provide clean, versatile, renewable energy. This simple device has no moving parts, negligible maintenance costs, produces no pollution and has a lifetime equal to that of a conventional fossil fuel. Photovoltaic cells capture solar energy and convert it directly to electrical current by separating electrons from their parent atoms and accelerating them across a one way electrostatic barrier formed by the function between two different types of semiconductor material [5].

Photo Voltaic Effect on Semiconductors

Semi conductors are materials which are neither conductors nor insulators. The photo voltaic effect can be observed in nature in a variety of materials but semiconductors has shown best performance. When photons from the sun are absorbed in a semiconductor they create for electrons with higher energies than the electrons which provide the boarding in the base crystal. Once these electrons are created, there must be an electric field to induce these higher energy electrons to flow out of the semiconductor to do useful work. The electric field in most solar cells is provided by a junction of materials which have different electrical properties. To understand more about the functioning and properties of semiconductors, let us briefly discuss. Semi conductors are classified into 1) Extrinsic Semiconductor 2) intrinsic semiconductor. Semiconductors in its purest form are called intrinsic and when impurities are added it is called extrinsic. Further extrinsic semiconductors are divided into p type and N type semiconductor.

P-Type Semiconductor

When a small amount of pentavalent impurities (e.g. Gallium, Indium, Aluminum, and Boron) are added to intrinsic semiconductor, it is called as p type semiconductor. In p type semiconductor, when an electric potential is applied externally, the holes are directed towards the negative electrode. Hence current is produced.

N- Type Semiconductor

When a small amount of pentavalent impurities (e.g. Antimony, Arsenic, Bismuth, Phosphorus) are added to intrinsic semiconductors it is called N type semiconductor. When an external electrical field is applied the free electrons are directed towards positive electrode. Hence current is produced.

III. ENVIRONMENTAL IMPACT OF SOLAR POWER

Air Pollution:

This can be caused by chemical reactants used in storage or organic fluids for heat transport. The release of CO, SO2, SO3, hydrocarbon vapors and other toxic gases should be accounted, through their magnitude is not high. The fire hazard associated with overheated organic working fluids exists. Human tissues when exposed would be destroyed because of high energy flux densities.

Land Use:

Solar plants require large land and the collection field produce shading not normally present over large areas. This may cause disturbance in local ecosystem.

Noise and Thermal Effect:

The thermal effects of solar plants are minimal. Actually these systems eliminate local thermal pollution associated with fossil fuel combustion. Some reduction in local environmental heat budget or balance will occur if electricity Produced is exported elsewhere. Solar systems do not add any new noise to that already existing in the present industrial or utility areas [5].

Major advantages of solar cells

1) Solar cells directly convert the solar radiation into electricity using photovoltaic effect without going through a thermal process.
2) Solar cells are reliable, modular, durable and generally maintenance free and therefore, suitable even in isolated and remote areas.
3) Solar cells are quiet, benign, and compatible with almost all environments, respond instantaneously with solar radiation and have an expected life time of 20 or more years.
4) Solar cells can be located at the place of use and hence no distribution network is required.

Major Disadvantages of Solar Cells

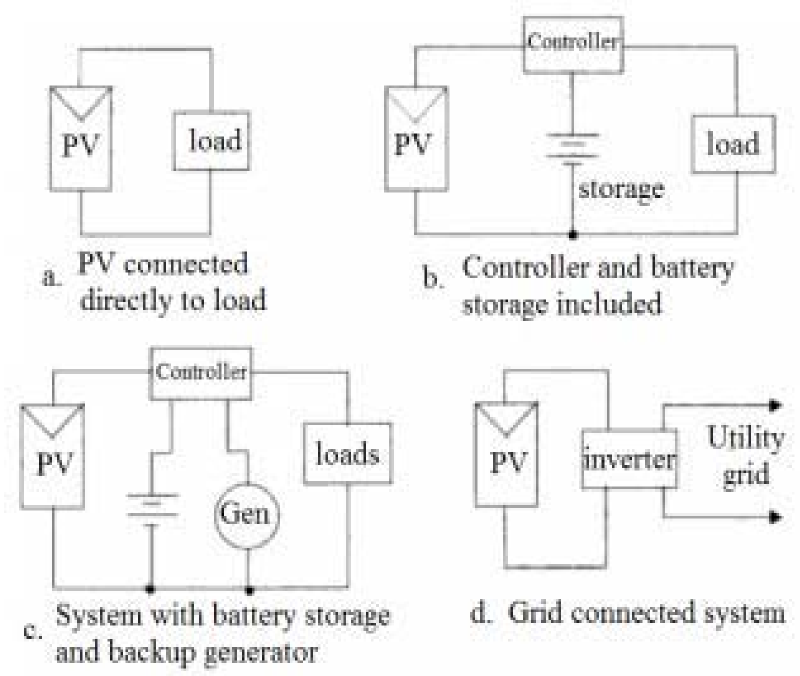
1) The conversion efficiency of solar cells is limited to 10 percent. Large areas of solar cell modular are required to generate sufficient useful power.
2) The present costs of solar cells are comparatively high, making them economically uncompetitive with other conventional power generation methods for terrestrial applications, particularly where the demand of power is very large.
3) Solar energy is intermittent and solar cells produce electricity when sun shines and in proportion to solar intensity. Hence, some kind of electric storage is required making the whole system more costly. However, in large Installations, the electricity generated by solar cells can be fed directly into the electric grid system.

IV. FUTURE ADVANCEMENTS

Although 86% of PV cells are designed with this first generation semiconductor approach, second and third generation cells consist of thin film deposits and electron confined nanoparticle materials. Thin film technologies reduce the required mass of light absorbing material, resulting in reduced processing costs but also reduced energy conversion efficiency. Because these thin films are nearly mass-less, they can be stacked to form multiple layer film cells which yield an average of 30% efficiency while standard semiconductor efficiency is limited to 14% [9]. Utilizing the same thin-film light absorbing materials, nanocrystalline solar cells increase efficiency as they are covered with an extremely thin coating of mesoporous metal oxide whose high surface area helps to increase internal reflections and ultimately light absorption probability and efficiency. This increase of Internal reflection helps to boost nanocrystalline PV cell efficiency to over 40%.

V.CONCLUSION

PV cells are a proven environmentally begning 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. 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 [5].



Examples of PV system

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