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# SOLAR POWER

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**ABSTRACT** *Solar energy is a way to solve the energy crisis developed in the modern time. In this paper, solar cells, their working, advantages and limitations has been discussed. Their applications in solar vehicles, devices and space technology have been pointed out. Various types of solar cells based on the constituent material are mentioned.*

**KEYWORDS : solar power, photoelectric effect, semiconductor, multi-junction cells**

## INTRODUCTION

Energy is one of the main factors that must be considered in discussions of sustainable development. There are many problems related with the energy supplies that are used today. Global warming is one of them. Global warming takes place due to effluent gas emission, mainly $CO_2$. Problems with energy supply and use are related not only to global warming but also to environmental concerns as air pollution, acid precipitation, ozone depletion, forest destruction, and emission of radioactive substances. Increasing world population creates a big demand for energy resources. Indeed, In response to the critical need for a cleaner energy technology, some potential solutions have evolved, including energy conservation through improved energy efficiency, reduction in the consumption of fossil fuels, and an increase in the supply of environmental-friendly energy, such as renewable sources and fuel cells.

## SOLAR POWER

Solar power is energy obtained from the sun. "Solar" is the Latin word used for "sun". Inside the sun the nuclear fusion process takes place. In this process small nuclei are fused together to form heavier nuclei. This process generates a lot of energy. Without sun, life on the earth is not possible. Sun is tremendous source of energy for future because of the vast amounts of energy made freely available. By using new and advanced technologies, this energy can be put to work in many ways from heating water and living spaces within homes to generate electrical energy [1].

### Advantages of solar power

Solar energy is a source that is not only sustainable for energy consumption but also indefinitely renewable. It is estimated that the world's oil reserves will last for 30 to 40 years. On the other hand, solar energy is forever. It is a clean source of energy. It does not produce greenhouse gases, such as carbon dioxide, which contributes to global climate change. Solar energy is a cheap source of energy although there is a cost in the building of 'collectors' and other equipment required converting solar energy into electricity or hot water. Solar energy can be used in remote areas where it is too expensive to extend the electricity power grid. Solar panels also require little maintenance. After installation and optimization they are very reliable due to the fact that they actively create electricity in just a few millimeters and do not require any type of mechanical parts that can fail.

### Limitations of solar power

Unfortunately, we cannot rely on solar energy alone. Solar energy cannot be harnessed in the night, and in some days, clouds and rains and other natural conditions prevent the sun's powerful rays to reach. Solar power is used to charge batteries so that solar powered device can be used at night. However, the batteries are large and heavy and need storage space. They also need replacing from time to time. Solar collectors, panels and cells are relatively expensive to manufacture although prices are falling rapidly. Solar power stations can be built but they do not match the power output of similar sized conventional power stations. They are also very expensive. Large areas of land are required to capture the suns energy. Collectors are usually arranged together especially when electricity is to be produced and used in the same location. Solar panel energy output is maximized when the panel is directly facing the sun. This means that panels in a fixed location, such as the building above, will see a reduced energy production when the sun is not at an optimal angle. Even today most efficient solar cells only convert just over 20% of the sun rays to electricity [2-4].

## SOLAR CELLS

Solar cells are devices that convert light energy directly into electrical energy. In these cells, the materials used are *semiconductors*. When the sun shines onto a solar cell, the phenomenon known as the photoelectric effect takes place. In this process material absorbs light and release electrons. These free electrons are captured by respective electrodes, due to which electric current is produced that can be used as electricity. Here doped silicon is preferred. These are of two types n-type, which has spare electrons, and p-type, which is missing electrons, leaving 'holes' in their place. When these two materials are placed side by side inside a solar cell, the n-type silicon's spare electrons jump over to fill the gaps in the p-type silicon. This means that the n-type silicon becomes positively charged, and the p-type silicon is negatively charged, creating an electric field across the cell. As the photons smash the electrons off the silicon atoms, this field drives them along in an orderly manner, providing the electric current [5].

### Single Junction and Multi Junction Cells

Today's most common photo voltaic devices use a single junction to create an electric field within a semiconductor. In a single-junction Photo voltaic cell, only photons whose energy is equal to or greater than the band gap of the cell material can free an electron for an electric circuit and lower-energy photons are not used. One way to get around this limitation is to use two or more different cells, with more than one band gap and more than one junction, to generate a voltage. These are referred to as multi-junction cells. Multi-junction devices can achieve higher total conversion efficiency because they can convert more of the energy spectrum of light to electricity.

Multi-junction device is a stack of individual single-junction cells in descending order of band gap ($E_g$). The top cell captures the high-energy photons and passes the rest of the photons on to be absorbed by lower-band-gap cells. The most common used material in multi-junction cells is on gallium arsenide as one or all of the component cells. Such cells have reached efficiencies of around 35% under concentrated sunlight. Other materials studied for multi-junction devices are amorphous silicon and copper indium diselenide [6].

## APPLICATIONS OF SOLAR CELLS

### Powering the Space Vehicles

Solar cells are very useful in powering space vehicles such as satellites and telescopes. They provide a very economical and reliable way of powering objects which would otherwise need expensive and cumbersome fuel sources. The international space station is also another good example of solar cells being used in space. When it is finished, the station will have the most powerful solar array in space.

### Solar Powered Vehicles

Solar powered cars are the cars powered by an array of photovoltaic cells. The electricity created by the solar cells either directly powers the vehicle through a motor, or goes into a storage battery. These solar powered vehicles are mainly used in research, educational tools or to compete in the various races for solar powered vehicles. The first

solar powered car was built by Ed Passerini in 1977. Many races for solar powered vehicles occur throughout the year. These serve to develop new technologies and show the public the idea of solar power as a viable power source. One of the first and most famous races is the World Solar Challenge, a 1872 mile race held in Australia. In 1996 Honda won with an average speed of 55.77mph. However, these kinds of average speeds can only be obtained with good weather conditions and huge investment in the vehicle [7].

### Standalone Devices

In remote locations grid connections are sometimes not possible. Some critical applications may need backup power for safety and redundancy. Solar energy is naturally a good fit for these situations. Many applications do not have access to direct sunlight. The photovoltaic panels function in diffuse and relatively low light conditions, including indoors. Portable electronic devices have become indispensible to our everyday lives and modern micro-electronics and 3rd generation photovoltaic technologies portable devices are beginning to tap ambient light as a power source [8].

## TYPES OF SOLAR CELLS

There are a number of variations of solar cells, the two most common types are those made of crystalline silicon (mono crystalline and poly crystalline) and made by thin film technology.

### Silicon Solar Cells

The majority of the solar cells (90%) on the market today are made of some type of silicon. However, silicon can take many different forms. The majority of silicon based solar cells (about 95%) are made up of crystalline silicon, making this the most common type of solar cell. There are two types of crystalline materials: mono crystalline and polycrystalline.

**Mono crystalline solar cells**: Mono-crystalline solar cells are made out of "silicon ingots," a cylindrically shaped design that helps optimize performance. Essentially, designers cut four sides out of cylindrical ingots to make the silicon wafers that make up the mono-crystalline panels. In this way, panels comprised of mono-crystalline cells have rounded edges rather than being square. These are the most efficient of all having efficiencies more than 20%. These are also the most space-efficient as fewer cells are used per unit of electrical output. In this way, solar arrays made up of mono-crystalline take up the least amount of space relative to their generation intensity. Another advantage of mono-crystalline cells is that their life time is the longest of all types. The mono-crystalline cells are superior of all but solar panels made of mono-crystalline cells are the most expensive of all solar cells. The reason for mono-crystalline cells so expensive is that the four side cutting process ends up wasting a lot of silicon, sometimes more than half.

**Polycrystalline Solar Cells:** From an investment standpoint, polycrystalline and thin film cells are often the preferred choice for consumers. In these cells, cutting process is not used. Instead, the silicon is melted and poured into a square mold, hence the square shape of polycrystalline. Thus these are much affordable since hardly any silicon is wasted during the manufacturing process. However, polycrystalline cells are less efficient than mono-crystalline cells. Typically, polycrystalline solar cells have 13-16% efficiency because of lower purity of material. Due to this polycrystalline cells are less space-efficient. One other drawback of polycrystalline is that these have lower heat tolerance than mono-crystalline, thus they don't perform as efficiently at high temperatures.

Thin Film Solar Cells

Thin Film solar cells are characterized by the manner in which various type of semi-conducting materials are layered on top of one another to create a series of thin films. These thin film solar cells achieve efficiencies of 7-13%. The major advantage of thin film technologies is their cost. Mass production is much easier than crystalline-based modules, so the cost of mass producing thin film solar cells is relatively cheap. The product itself is also flexible in nature. Another point is that high heat and shading have less of a negative impact on thin film technologies. For these reasons, the thin film market continues to grow. One major drawback is that thin film technologies require a lot of space. As a result, thin film is used more in the commercial space. These thin film solar cells have a shorter life than their crystalline counterparts [9].

## CONCLUSIONS

Sun is a tremendous source of energy. Use of solar energy can help us to get rid of many environmental problems. Besides their low conversion efficiency, solar cells can be a substantial initial investment. The cost of solar panels incurred is only the initial cost, after buying and installation they create free energy for use. Solar technique is still in its infancy and lots more research and development needs to be done before they can get close to the production line.

## REFERENCES

[1]http://www.eschooltoday.com/energy/renewable-energy/solar-energy.html [2]http://www.technologystudent.com/energy1/solar7.htm [3]http://study.com/academy/lesson/what-is-solar-energy-definition-lesson-quiz.html [4]http://www.tc.umn.edu/~dama0023/solar.html [5] http://www.physics.org/article-questions.asp?id=51 [6]http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/ [7]http://www.chm.bris.ac.uk/webprojects2003/ledlie/uses_of_solar_cells.htm [8]http://www.solaronix.com/solarcells/applications/ [9]http://www.altenergy.org/renewables/solar/common-types-of-solar-cells.html