International Research Journal of Natural and Applied Sciences
Vol. 4, Issue 2, February 2017 Impact Factor- 5.46
ISSN: (2349-4077)
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"IT CONVERTS THE ENERGY OF LIGHT INTO ELECTRICITY- SOLAR CELL CONCEPTS"

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ABSTRACT

The purpose of this case study to understand the concept of solar energy. How sunlight energy in converted into electricity using solar energy concept?

Solar energy obtained from the sun. Solar cell is the cell which is the conversion of solar energy into electrical energy. It is an electrical device by using photovoltaic effect (physical and chemical phenomenon). Solar cell is also known as photovoltaic cell. Photovoltaic cell uses the energy of light (source of light can be sunlight or an artificial light) to convert directly into electricity.

Various advantages it can bring to customer and environment are; it is clean and non-polluting source of energy, it is a renewable energy source, solar cells do not produce noise and they are totally silent, require very little maintenance, are long lasting sources of energy which can be used almost anywhere, have long life time and are no fuel costs or fuel supply problems.

OBJECTIVES

- Understanding of Solar cell
- How PV cells or panel work?
- Understand the crystal used in different types of solar cells
- Working of PV(photovoltaic) lighting systems
- Applications of Solar Energy
- Technologies shaping the future of solar power

KEYWORDS

- Photovoltaic cells
- p-n junction
- Solar panel
- Photo electrochemical cell
- Bio-solar cells or panel
- Floating panels

INTRODUCTION

Brief on Solar Cell

A solar cell is a device which directly convert a sunlight into electricity. Shining of light on the solar cell generates electric power as it produces both current and the voltage. The process requires firstly a material in which an electron is raised through absorption of light to a higher energy state, secondly this energy converted into an external circuit from the solar cell. Then the electron dissipates energy into external circuit and return to solar cell.

Semiconductor device which is made up of silicon (solid state diode) is the most common type of solar cell. Solar panels are made up of many number of solar cells these are wired together to form a desired output current and voltage. These cells are covered with the glass window and protective packages.

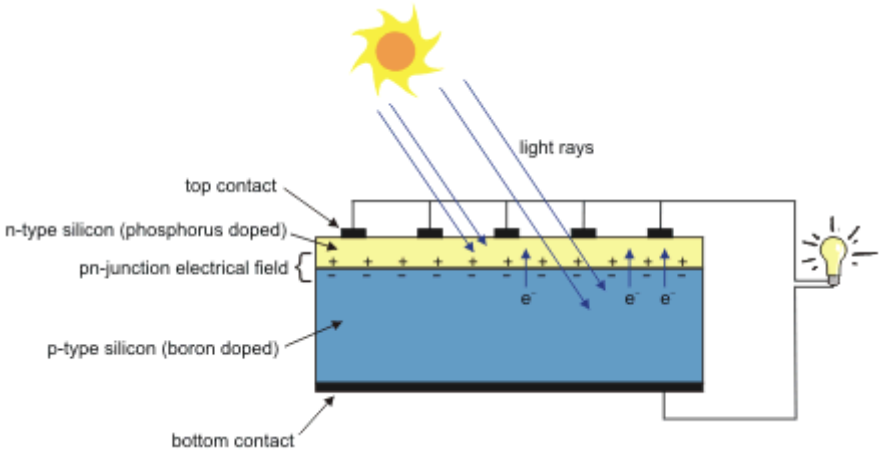
Photovoltaic effect: It's a chemical and physical phenomenon/process to generate current and voltage in a material when sunlight is fall on material. Using this effect, the solar cells generate electric power.

On earth, sun is the resource of energy for lifetime. It creates a sustainable clean energy and reduce demand for grid power using photovoltaic collection systems. They have the capability to power lightening systems.

How do PV cells or panels work?

Light may be absorbed, transmitted or reflected when hits the surface. Absorption of light is the process which converts the energy in the incident photons into some other form of energy like electrical energy. A PV panel consists of connected PV cells having one or more PV modules.Fig1 showing the structure and working of a PV cell.

Fig1. PV cell structure and working



Explanation

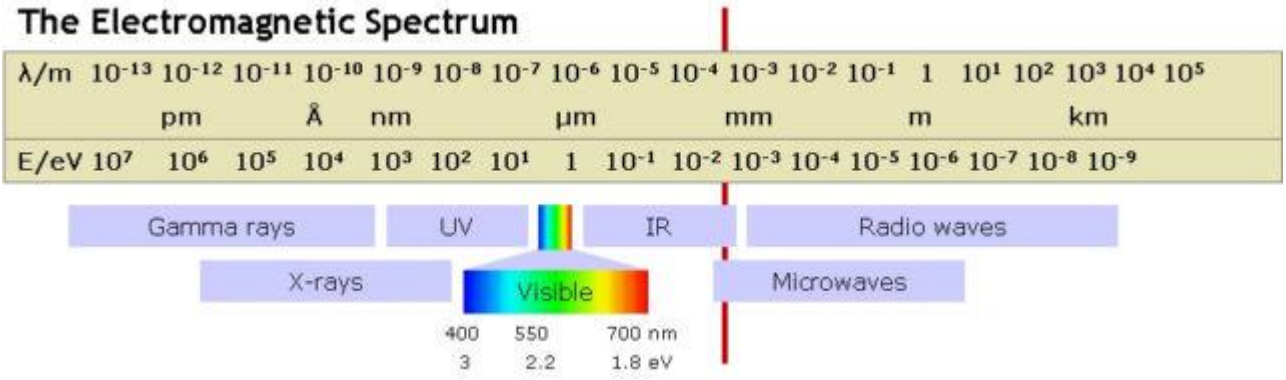
A PV cell which consists of silicon usually contains two layers. In a silicon crystal, a solar cell is formed from a p-n junction. Different areas of the crystal with different impurities created a junction which is made by "doping".The topmost layer consists of a thin sheet of negatively charged or n-type (phosphorus-doped) silicon. Under this layer there is thick sheet of positively charged or p-type (boron-doped) silicon.

A positive-negative (p-n) junction is created when these two materials are in contact which is the unique characteristic of these two layers.The p side has holes where electrons are missing, and they are current carriers. The other side is a conductor with electrons is called n side.

When sun light contacted with the PV cells, an electric potential is created through p-n junction. P-type silicon layer electrons will move across the p-n junction to the n type silicon layer, when the sunlight hits PV cells. This causes the higher voltage potential in the P-type layer rather than the n-type layer.Energy of the photons are usually fixed that means their energy is quantized. So, the energy is less than the infrared part of the spectrum which will not create charge carrier and it heat the panel. If the combined energy of two infrared photons are not enough to bridge the gap then a photon with excess energy will lose an electron and the excess energy will be wasted.

Efficiency is the ratio of light energy striking the panel divided by electrical energy extracted. In this case the light energy is wasted so the efficiency will not be 100 percent. So, the electric current flows when PV cell is connected to a load. The voltage about 0.5 to 0.6 volts dc under open-circuit with no load conditions is been created by silicon cell. Intensity of the

solar radiation and the surface area of the PV cell causes power of a PV cell. The band gap is 1.1 electron volts (eV) of a silicon PV solar cell. In the diagram of the electromagnetic spectrum the visible spectrum lies above this, so visible light of any colour will produce electrical power. Also, it means that for each photon absorbed, excess energy is wasted and converted into heat.



There are three types of solar cells based on crystal used in it:

1. Mono crystalline silicon cells – These are produced by single crystal i.e., pure silicon. It is defect free and pure and its efficiency of cell will be high.
2. Polycrystalline silicon cells –In these cells solidification process is used to obtain polycrystalline silicon and its raw material is liquid silicon. Its efficiency is less than Mono crystalline cell.
3. Amorphous silicon cells –It is obtained by depositing silicon film on the glass plate (a substrate). The layer thickness is less than 1μm – the thickness of a human hair for comparison is 50-100 μm.

Inventions includes lightening applications which depends on complex set of technical, environmental and cost variables. Performance is also considered when to use PV systems instead of power lightening. Solar cells and PV collections systems were first introduced in 1950's but at that time there were limited number of applications were used for lightening. At that time initial purchase and maintenance cost was too high. And also,was unreliable light production, installing PV system and complexities in designing. PV lightening systems were also demonstrated for parking lots and roadways applications. So they focuses in rural or remote areas where the light levels similar to moonlight was sufficient for the task performed.

Working of PV(photovoltaic) lighting systems

In this system solar radiations are replaced by the coal or natural gas which are burning of fossil fuels. A PV lighting system consists of a light source (lamp), an electronic circuits, PV panel, battery, and luminaire (optics). Transformation of solar energy into electrical energy is done by PV panels. A PV panel is consisting of many PV cells and these PV cells are created by semiconductor positive-negative (p-n) junction. The PV cells can store electrical energies in a battery for later use and also it can energize light sources like lamps.

Applications of Solar Energy

1. **Homes**: Use of solar energy is increasing in homes day by day. Solar power generated electricity is used in residential appliances. Solar heaters are used to supply hot water in homes. Using batteries, the photovoltaic cells installed on the roof, the house energy is being stored for different purposes n homes throughout the day. So the expenses are getting low.
2. **Solar Cars**: Solar panels used in the cars to absorb light which then converts the light into electrical energy. This energy is stored in the batteries of the cars. These vehicles are recharged from the sunlight or the solar energy. So that in night these vehicles can be used.
3. **Power plants**: In these plants water is boiled using the non-renewable energy sources and the stream is formed. So, the turbines can rotate and produce electricity. Photelectric technologies, thermoelectric technologies and solar panels are used to convert sunlight into electricity.
4. **Commercial Use**: We can find glass PV modules or any other kind of solar panel on roofs of different buildings. The supply of electricity to the parts of building and different offices in a reliable manner using these panels. These offices use their own electrical power using these panels which collects solar energy from sun and converts it into electricity for different purposes.
5. **Swimming pools**: It always a great joy for all in all the seasons. But difficult to maintain hot water with minimum power usage in winters. So Solar energy helps to maintain it with low cost. Solar blankets are kept in the pools to keep the water hot and the energy is generated from sunlight. Also, you can use solar hot water heater with solar heating panels

6. **Power pump:** circulation of water in any building and ventilation system at your homes is improved by solar power. By connecting 6 power pumps with solar power supply unit which must run on DC current can circulate water throughout your home.
7. **Ventilation system:** Solar energy is used for ventilation purposes at many places. Inbuildings,it helps in running bath fans, floor fans, and ceiling fans. To control moisture, and smell and in homes to take heat out of the kitchen the fans almost runs every time in a building. It cut down the electricity bills by using solar energy for ventilation purposes.

5 things you should know about solar energy

1. Silicon solar cell was first built in 1954 by Bell Laboratories.
2. Solar energy is the resource which is available in large amount on earth. 173,000 terawatts of solar energy strike the Earth continuously which is 10,000 times more than the world's total energy use.
3. Space industry used solar technology in 1960s to provide power abroad spacecraft. First artificial earth satellite was Vanguard 1 which was powered by solar cells. It was the oldest manmade satellite in orbit.
4. Solar energy is increasingly becoming an economical energy choice as prices continue to fall for homeowners and businesses. Still, it remains the soft costs like permitting, zoning, and hooking a solar system up to the power grid is the biggest hurdle to a affordable solar energy.
5. The largest solar energy project in the world is under construction in California's Mojave Desert. The project depends on a technology known as solar thermal energy. 350,000 mirrors will reflect light onto boilers, once this project is complete. It creates electricity when the water boils, the steam turns a turbine. The expectation from this project is to provide clean, renewable energy for 140,000 homes and it is supported by an Energy Department loan guarantee.

Next generation solar cells

A newly discovered nanotube structure would be capable of transporting electrical charges which will be 100 million times higher than previously measured will be most useful. Carbon

nanotubes have been developed as the inefficiency in the material because most of the solar cells use silicon to absorb light. Light absorption capabilities of the current cells can be enhanced by the carbon nanotubes. Solar panels made from the mineral are of new generation which are called Perovskite. According to a study from Briain's Exeter University, Perovskite converts solar energy into household electricity at very low cost. For India and African countries, super-thin, custom-coloured panels attached to a building's windows may become a "holy grail". It can produce electricity and can shade windows at the same time. And its thickness is measured in billionths of meters.

TECHNOLOGIES SHAPING THE FUTURE OF SOLAR POWER

- **Bio-solar cells**

Researchers connected nine biological-solar (bio-solar) cells into a bio-solar panel for the first time ever. It produced electricity from the panel and generated the most wattage of any existing small-scale bio-solar cells continuously. This time nine identical bio-solar cells in a 3x3 pattern is being used to make a scalable and stackable bio-solar panel. This panel generateselectricity from photosynthesis and respiratory activities of the bacteria continuously in 12-hour day-night cycles over 60 total hours.

- **A new way for converting solar energy into electricity**

A new paradigm for the development of photo-bio electrochemical cells in Nature Energy has been reported by the researchers from The Hebrew University of Jerusalem in Israel, and the University of Bochum in Germany, it providesthe means for the conversion of solar energy into electricity. In the photosynthesis process the plants and other organisms make their food using water , carbondioxide and sunlight , a bio electrochemical systems take advantage of these biological capacities (like microbes, enzymes, plants) for the catalysis of electrochemical reactions. Using the native photosynthetic reaction and the enzymes glucose oxidase, or glucose dehydrogenase the researchers constructed photo-bio electrochemical cells.

- **Floating panels, floating solar farms**

There is a lack of space to install large-scale ground-mount solar systems in many countries. Companies are introducing ecological alternative solutions to avoid taking large farmlands for ground-mount solar systems. A large scale of floating solar solutions has been developing by the firm French company Ciel & Terre International since 2011. Its Hydrelio Floating PV system allows standard PV panels to be installed on large bodies of water. Like drinking water reservoirs, irrigation canals, tailing ponds, and hydroelectric dam reservoirs, remediation and quarry lakes. It is suitable for water-intensive industries that cannot afford to waste either land or water so it's a simple and affordable alternative to ground mounted systems. This system is installed in the UK till date. And the projects has also been setting up in such countries like India, France and Japan.

- **Solar energy harvesting trees**

The researchers have used solar and 3D printing technologies at the VTT Technical Research Centre in Finland develops "energy harvesting trees" as a prototype. Small leaves are used to power small appliances and mobile devices as it generates and store solar energy. They flourish indoors and outdoors and can also harvest kinetic energy from wind and temperature changes in the surrounding environment. Tree leaves are printed using well-established mass-production techniques because leaves are flexible organic solar cells. Each leaf has a separate power converter, creating a multi-converter system that makes it possible to collect energy from a variety of sources such as solar, wind and heat temperature.

In a tree there are more solar panels so that the more energy can be harvested. The trunk of the tree is made up of 3D technology by exploiting wood-based biomaterials.

- **Transmitting solar power wirelessly from space**

The aim of the Japanese Space Agency (JAXA)'s Space Solar Power Systems (SSPS) is to transmit energy from orbiting solar panels by 2030. Mitsubishi Heavy Industries Ltd (MHI) successfully conducted a ground demonstration test of "wireless power transmission" on 12 March, it's a technology that will serve as the basis for the SSPS.Via a microwave unit 10kW of electricity was successfully transmitted in the test. Power reception was confirmed at a receiver located 500 metres away. LED lights on the receiver confirmed the transmission. It's a new achievement in transmission.

CONCLUSION

Solar energy is the combination of heat and light which is taken by sun. Sun is the best source of heat and light. On earth, solar collectors are used to collect this energy which moves from sun and reaches to us. And humans convert this energy into any form which is required. So, this source of energy is renewed and powerful enough to replace the need of electricity. The electricity on earth we needed, and we get from is about 650 barrels of oil per year.So, this concept replaces this using sunlight and it is low in cost. And it will be very reliable and non-polluting so it's an advantage to environment also. It's a cheap source of energy and can provide output for large number of customers. Many technologies have been developed so far which are using solar cells in daily life.

REFERENCES

- Solar Electricity Basics: A Green Energy Guide, Dan Chiras, Publisher: New Society Publishers
- Solar Electricity Handbook - 2014 Edition: A Simple..., Mr Michael Boxwell, Publisher: Greenstream Publishing, Edition no. 8 (12/06/2013)
- Photovoltaic Design and Installation For Dummies, Ryan Mayfield, Publisher: For Dummies, Edition no. 1 (09/07/2010)
- Profiting from sunshine: passive solar building in the mountains. Edited by N. K. Bansal and Kamal Rijal. Kathmandu, International Centre for Integrated Mountain Development, c2000. 284 p. Includes bibliographical reference. TH7687.9.P76 2000
- Handbook of photovoltaic science and engineering. Edited by Antonio Luque and Steven Hegedus. Hoboken, NJ, Wiley, c2003. 1138 p. Includes bibliographical references. TK8322.H33 2003
- Planning and installing solar thermal systems: a guide for installers, architects, and engineers. The German Solar Energy Society (DGS). London, Sterling, VA, James & James/Earthscan, c2005. 298 p. Bibliography: p. 291-292.TH7413.P534 2005
- Solar thermal technologies for buildings: the state of the art. Edited by M. Santamouris. London, James & James (Science Publishers) Ltd., c2003. 240 p. Includes bibliographical references. TH7413.S6265 2003

- Designing with solar power: a source book for building integrated photovoltaics (BiPV). Edited by Deo Prasad and Mark Snow. London, Sterling, VA, Earthscan, 2005. 252 p. Bibliography: p. 239-249.TK1087.D475 2005
- http://www.ques10.com/p/9330/explain-with-neat-diagram-construction-and-worki-1/
- https://www.sciencedirect.com/science/article/pii/S0927024800002671
- https://onlinelibrary.wiley.com/doi/abs/10.1002/pip.533