Cheap Renewable Energy: Use of Recycled Semiconductors as Photovoltaic Cell

Albert Patrick J. David

***Abstract* -** All kinds of work by human beings and nature is measured primarily as energy. It is a crucial input in the process of economics, social and industrial developments. As conventional energy sources are depleting day by day, the sought for alternative means of generating energy presents a viable solution. The increase in power demand, the depleting fossil fuel sources, and the growing environmental pollution has made the world to reconsider alternative sources of energy. This study resorts to the use of cheap and recycled materials to devise a prototype that can harness energy using photovoltaics. PV are the conversion of light into electricity using semiconducting materials. It exhibits the photovoltaic effect, a phenomena that is studied in physics, photochemistry, and electrochemistry.

A typical photovoltaic system employs the use of the conventional solar panel, each composes a number of solar cells, and in this study the researcher uses a semiconductor to act as a solar cell to generate electrical power. The semiconductors used are recycled diodes which are cheap, readily available and can be recycled from old electronic components.

***Keywords* –** semiconductor, photovoltaics, energy, diodes

I. Introduction

A solar cell or photovoltaic cell is an electrical device used to convert sunlight into DC energy. In 1839, nineteen-year-old Edmund Becquerel, a French experimental physicist, discovered the photovoltaic effect while experimenting with an electrolytic cell made up of two metal electrodes. Becquerel found that certain materials would produce small amounts of electric current when exposed to light [1]. In 1878, a solar-powered steam engine was invented by a French mathematician, August Mouchet, after receiving funding from the French government to work on an alternative source of energy. He created the first solar steam-powered plant using parabolic dish collectors. The plant was a central attraction of the World Exposition in Paris in 1878. This method of creating solar energy is still used today, although the French government didn't provide further funding as it was deemed too expensive [2].

Photons in sunlight are absorbed by a semiconducting material such as silicon. The converted energy from light can be used to power equipment or can be stored in a battery. The depletion region as explained previously with the diode is the area around the p-n junction where the electrons from the N-type silicon, have diffused into the holes of the P-type material. When a photon of light is absorbed by one of these atoms in the N-Type silicon it will dislodge an electron, creating a free electron and a hole. The free electron and hole has sufficient energy to jump out of the depletion zone. If a wire is connected from the cathode (N-type silicon) to the anode (P-type silicon) electrons will flow through the wire. The electron is attracted to the positive charge of the P-type material and travels through the external load (meter) creating a flow of electric current. The hole created by the dislodged electron is attracted to the negative charge of N-type material and migrates to the back electrical contact. As the electron enters the P-type silicon from the back electrical contact it combines with the hole restoring the electrical neutrality.

A silicon diode is a semiconductor that has positive and negative polarity, and can allow electrical current to flow in one direction while restricting it in another. The element silicon, in its pure form, acts as an electrical insulator. A diode is a two-terminal electronic component with asymmetric conductance; it has low (ideally zero) resistance to current in one direction, and high (ideally infinite) resistance in the other [3].

A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials in the form of a p-n junction. Basically, a solar cell as a p-n junction electrical component is also a p-n junction diode.

Electricity production using photovoltaic has been facilitated by one key factor, the decline of the unit cost of silicon based materials. Thus, these phenomena made photovoltaic electricity production to reach "grid parity" all over the world. It is estimated that 50% of the world's energy generation will come from the photovoltaic technology this 2017 [4].

II. Objectives of the Study

The general objective of this study is to devise a generator which uses alternative source of energy that can be used to harness electricity. The energy that will be gathered can be used in different applications.

This research has the following specific objectives:

1. To design and construct a photovoltaic cell that generates

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electrical energy from sunlight.

2. To determine the type of Semiconductors to be used as photovoltaic cell that will generate energy.
3. To identify the electronic circuit to be used to harness usable amount of electricity.
4. To test the device and evaluate the results of the study.

The study focuses on the design and development of Photovoltaic cell using semi-conductors. This research will help and benefits lots of sectors of the community. This study will only cover a photovoltaic cell that generates electrical energy from sunlight, silicon diodes used are readily available in the market, other sources of diodes are to be recycled from electronic wastes, and this study also acts as electronics wastes management if recycled diodes will be used. However, the following limitations are met; In comparison with the conventional solar/photovoltaic cell, a single diode has a small surface are, thus requiring multiple diodes to attain a desired voltage.

This study used the zener diode solely because other types of diodes have protective coating covering the silicon material. However, these types of diodes are still usable if the semiconducting material will be exposed.

III. Conceptual Framework

The following diagram shows an input, process, output (IPO) conceptual framework shown in figure 1.1 that leads to the development of the study.

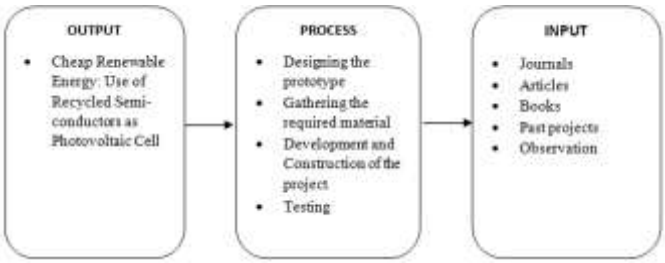


Fig. 1 "IPO Block Diagram"

The input necessary for the development of this study is gathered form published electronic journals, electronic articles, books, past projects and observation. This is required to come up to an idea related to the technology.

The process by which the prototype is develop consists of defined step-by-step procedures such as designing the prototype, selecting and gathering the required materials, development and construction of the project and finally, testing of the project.

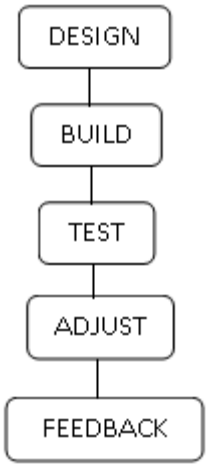
This represents the procedure in the development of Photovoltaic Cell using Semi-conductor Diodes. Working plan should be carefully follow and will lead to the development of the project. Testing and evaluation should be done to determine whether the specified goals and objectives are met by the system and doing necessary modifications if needed.

IV. Methodology

Innovations communicated verbally are often difficult to imagine. Since they are abstract ideas, it is difficult to get a sense of what they will look and feel like. Rapid prototyping is the act of creating a low-fidelity object for the purpose of testing a concept. Through rapid prototyping, a designer is able to quickly test and adapt a design with minimum investment in time and the cost of failure. During solution design, Rapid Prototyping allows for concept testing, accelerating the innovation process.

Using anything at hand to mock up rough concepts, giving form to early ideas and hunches is a prototype. The purpose of the building is to think, to understand existing experiences and user needs, and to move abstractions into tangible objects with a low initial production cost. Ideas are explored, and learning occurs faster by failing earlier and often. Permission is granted to experiment, try and stretch. Ideas are communicated and shared to enhance the researcher's understanding. This method quickly moves thoughts into concrete objects for discussion.

Rapid Prototyping facilitates an interactive process:

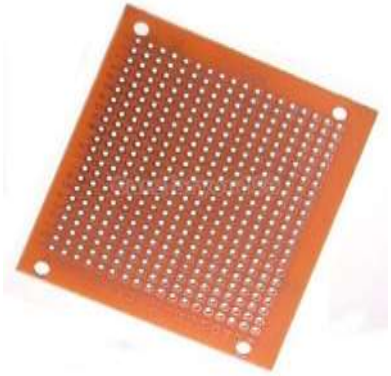


"The purpose of rapid prototyping is to demonstrate possibilities quickly by building an inexpensive series of mock-ups so designers are able to obtain early feedback from which they may respond to user requirements. This is particularly true in the following three types of situations: (1) cases that involve complex factors, which can make predictions difficult; (2) cases already examined by conventional methods without satisfactory results; and (3) new situations, which do not offer a lot of experience to draw from".

V. Design Considerations

Materials are needed to be prepared in regards with the development of the prototype. The following are selected to be used for this photovoltaic cell;

1) A zener diode is a diode which allows current to flow in the forward direction in the same manner as an ideal diode, but also permits it to flow in the reverse direction when the voltage is above a certain value known as the breakdown voltage, "Zener knee voltage", "Zener voltage", "avalanche point", or "peak inverse voltage"



2) Stripboard is the generic name for a widely used type of electronics prototyping board characterized by a 0.1 inch (2.54 mm) regular (rectangular) grid of holes, with wide parallel strips of copper cladding running in one direction all the way across one side of the board

3) A multimeter or a multitester, also known as a VOM (Volt-Ohm meter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic features such as the ability to measure voltage, current, and resistance.

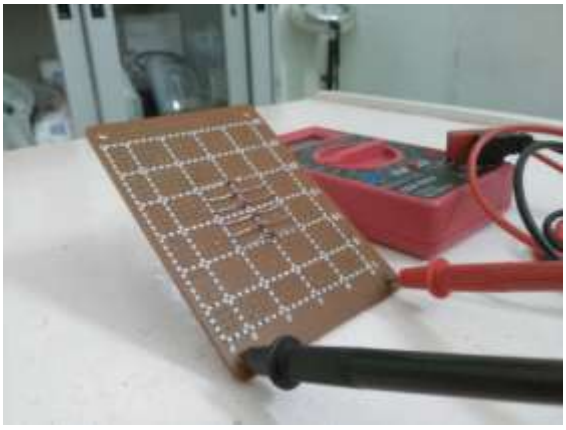


Fig. 2 “Photovoltaic Cell using Semi-conductor Diodes”

VI. Conclusion

This study presents how a *p-n* junction silicon electronic components harvests solar energy from the sun. With the completion of the study, it is clear that cogeneration power using recycled semiconductor diodes is a promising source and presents results feasibly economical with their use, especially if implemented on a wide scale. Photovoltaic (PV) technology is the method of generating power by converting sunlight into direct current electricity with the use of semi-conducting materials. It is also considered that studies and researches are made constantly to improve their efficiency and the requirements for reducing emissions of gases that causes global warming, as well as the need to use renewable sources are increasing, making the applications of photovoltaics become increasingly interesting and most sought after because it arouses the interest of the government and industries to utilize this technology. The most common method of generating such is with the use of Solar Cells. A Solar Cell is a *p-n* junction electronic component that is made of silicon. This study replicates a solar cell using a silicon semi-conductor diode such as ln4148 zener diode. Since a diode is also a *p-n* junction electronic component and is made of silicon, this study concluded that a solar cell is theoretically a large diode and thus proving that a small component like a diode can be used to convert energy coming from the sun. This concept of free energy can be made using simply recycled materials from our home or even industrial sources.

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