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Date : 9/3/05

DESIGN OF RESIDENTIAL – SITED PHOTOVOLTAIC GRID CONNECTED SUITABLE FOR MALAYSIAN ENVIRONMENT

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This Report Is Submitted In Partial Fulfillment Of Requirement For The Degree of Bachelor In Electrical Engineering (Industry Power)

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March 2005

"I admit this report is written by me except the summary and extraction for each I have been clearly presented"

Signature : ....

Writer Name : MOHAMAD NAJIB B. JASMANI

Date : 9/3/05

To my parents

Jasmani Ahmat and **Maimon Alias**

In appreciation of their patient and understanding.

ABSTRACT

This is a research to evaluate grid connected solar PV system application to whole residential in Malaysia. The evolution of photovoltaic (PV) based power generation systems for residential application in Malaysia not expanding than other country. In Malaysia, the usages of PV are still in its experimental stages. Located near the equator where received more solar radiation a Malaysia have good opportunities to develop this system. In the solar market, in which equipment and component required for the upcoming solar grid-connected pilot-project include photovoltaic solar panel modules with capacity up to5kWp. This project is part of a prominent four-year UNDP (United Nations Development Program) initiative known as the Industrial Energy-Efficiency Improvement Project and is being funded via a US$20.79 million grant. It is being implemented by an independent research organization known as the Malaysia Energy Center.

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CHAPTER 1

INTRODUCTION

The word photovoltaic (PV) can divide into two parts: *photo*, derived from the Greek words for light, and *volt*, relating to electricity pioneer Alessandro Volta. So, photovoltaic could literally be translated as light-electricity. A PV cell is a small energy conversion system that converts the sun's energy directly into electricity. The technology on photovoltaic systems comes expanding, mainly for safe source and clean energy sources [4]. It has several advantages:

i. They have no moving parts and produce power silently.
ii. They are non-polluting with no detectable emissions or odors.
iii. They are inherently stand-alone systems that reliably operate unattended for long periods.
iv. They require no connection to an existing power source or fuel supply.
v. They may be combined with other power sources to increase system reliability (hybrid systems).
vi. They can withstand severe weather conditions including snow and ice.
vii. They consume no fossil fuels - their fuel is abundant and free.
viii. They can be installed as modular building blocks - as your power demand increases, you may add more photovoltaic modules.

1.1 Energy from the Sun

The sun's energy is vital to life on Earth. It determines the Earth's surface temperature, and supplies virtually all the energy that drives natural global systems and cycles. Although some other stars are enormous sources of energy in the form of x-rays and radio signals, our sun releases 95% of its energy as visible light. Visible light represents only a fraction of the total radiation spectrum; infrared and ultraviolet rays are also significant parts of the solar spectrum.

Each portion of the solar spectrum is associated with a different level of energy (See Figure 1.1). Within the visible portion of the spectrum, red is at the low-energy end and violet is at the high-energy end (having half again as much energy as red light). In the invisible portions of the spectrum, photons in the ultraviolet region, which cause the skin to tan, have more energy than those in the visible region. Photons in the infrared region, which we feel as heat, have less energy than the photons in the visible region.

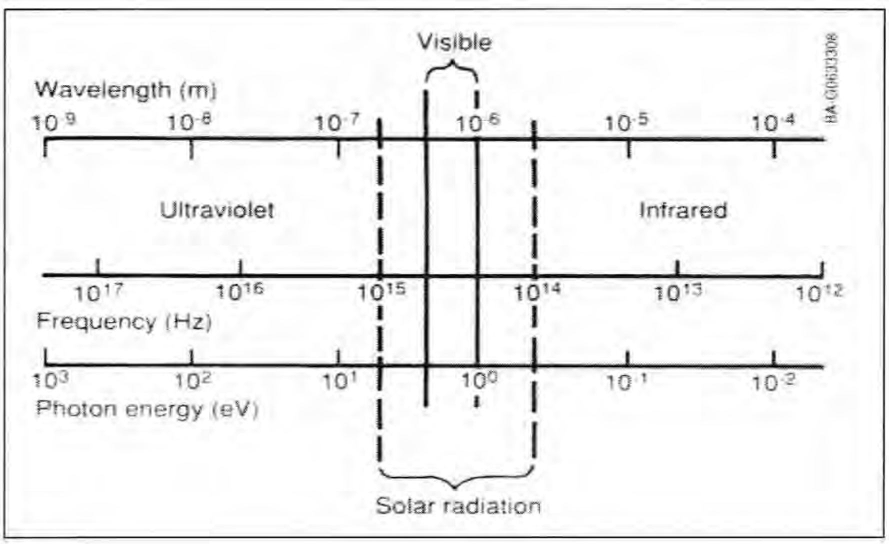

Figure 1.1 Level of energy

The movement of light from one location to another can best be described as though it were a wave, and different types of radiation are characterized by their individual wavelengths. These wavelengths-the distance from the peak of one wave to the peak of the next indicate radiation with different amounts of energy; the longer the wavelength, the less the energy. Red light, for example, has a longer wavelength and thus has less energy than violet light.

Each second, the sun releases an enormous amount of radiant energy into the solar system. The Earth receives a tiny fraction of this energy; still, an average of 1367 W reaches each square meter (m^2) of the outer edge of the Earth's atmosphere. The atmosphere absorbs and reflects some of this radiation, including most x-rays and ultraviolet rays (See Figure 1.2).

Yet, the amount of sunshine energy that hits the surface of the Earth every minute is greater than the total amount of energy that the world's human population consumes in a year.

When sunlight reaches Earth, it is distributed unevenly in different regions. Not surprisingly, the areas near the equator such as Malaysia receive more solar radiation than anywhere else on Earth. Sunlight varies with the seasons, as the rotational axis of the Earth shifts to lengthen and shorten days as the seasons change. The quantity of sunlight reaching any region is also affected by the time of day, the climate (especially the cloud cover, which scatters the sun's rays), and the air pollution in that region. These climatic factors all affect the amount of solar energy that is available to PV systems.

The amount of energy produced by a PV device depends not only on available solar energy but on how well the device, or solar cell, converts sunlight to useful electrical energy. This is called the device or solar cell efficiency.

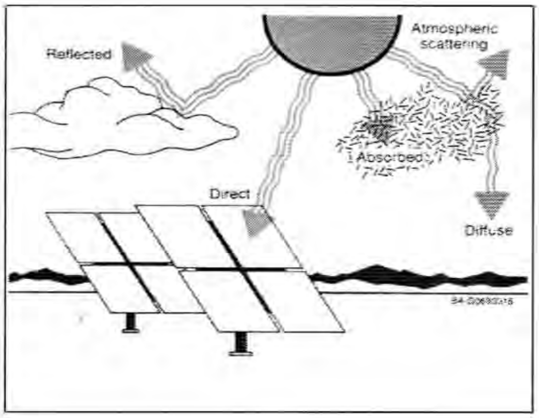

Figure 1.2 Effect of sun radiation from surrounding

1.2 Driving the Charge Carriers

When a photon of light energy is absorbed by a silicon atom, an electron hole pair is created, and both the electron and the hole begin moving through the material. If nature were left to take its random course, they would recombine in about a millionth of a second and contribute nothing to an electrical current. But PV cells are so constructed that minority carriers have a good chance of reaching the electric field before recombining (Figure 1.3).

When a minority carrier (on either side of the junction) comes close enough to feel the force of the electric field, it is attracted to the interface; if the carrier has sufficient energy, it is propelled over to the other side. Majority carriers, on the other hand, are repelled by this same electric field.

By acting this way, the field sorts out the photo generated electrons and holes, pushing new electrons to one side of the barrier and new holes to the other. This sorting-out process is what gives the push to the charge carriers in an electrical circuit. Without the electric field, charge carriers generated by the absorption of light would go nowhere except back into the lattice.

Attaching an external circuit allows the electrons to flow from the n-layer through the circuit and back to the p-layer, where the electrons combine with the holes to repeat the process. If there is no external circuit, the charge carriers collect at the ends of the cell. This buildup continues until equilibrium voltage (called the open circuit voltage) is reached (Figure 1.4).

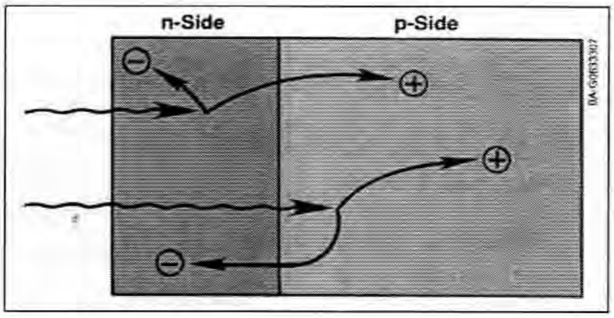

Figure 1.3 Process of recombining

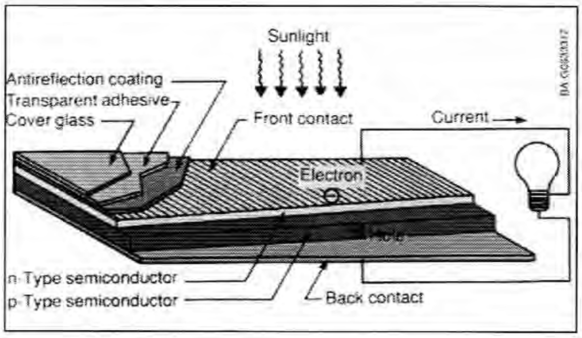

Figure 1.4 PV connecting to circuit

1.3 Scope of work

The objective of this project is want to design a residential PV system using the Photovoltaic (PV) technologies. Also want to obtain the residential data such as type of house, numbers of house, the specification about residential in Malaysia including whether pattern. Lastly want to evaluate the impact to PV system to the utility also to the TNB as supplier electricity in Malaysia. This project follows the methodology as describe below: -

- Identify types of Malaysian residential houses.
- Study of PV type and technology.
- Design sizes PV with it energy usage.
- Study whether pattern in Malaysia.
- Calculate the total generation capacity of PV housing system.
- Design the technical aspect of having residential PV.
- Identification of the generation impact of the utility.
- Identification of simulation application.
- Implementation of simulation

1.4 Report Organization

This reports are divided into four main chapter where: -

- Introduction
- Literature review
- Proposed Design
- Analysis of proposed design

The introduction chapters are explaining about the Photovoltaic system with method for better understanding and explanation about PV system. Literature review explain about the same project about PV in Malaysia and also the fundamental of PV. In Proposed design include all my proposed idea to make this project realized where there have many data from my survey. Lastly for the analysis of proposed design I put a calculation and table that help to find out the some value related to this case study.

CHAPTER 2

LITERATURE REVIEW

2.1 Forming the Electric Field

Photovoltaic cells contain an electric field that is created when semiconductors with different electrical characteristics come into contact. The electric field drives positive and negative charges in opposite directions. The movement of charge carriers (through an external circuit) is what defines electricity[6].There are several ways to form the electric field in a crystalline silicon PV cell. The most common technique is to slightly modify the structure of the silicon crystal. This technique, known as "doping," introduces an atom of another element (called the "dopant") into the silicon crystal to alter its electrical properties. The dopant has either three or five valence electrons, as opposed to silicon's four.

Phosphorus atoms, which have five valence electrons, are used for doping n-type silicon (so called because of the presence of free negative charges or electrons). A phosphorus atom occupies the same place in the crystal lattice that was occupied formerly by the silicon atom it replaced. Four of its valence electrons take over the bonding responsibilities of the four silicon valence electrons that they replaced. But the fifth valence electron remains free, without bonding responsibilities.

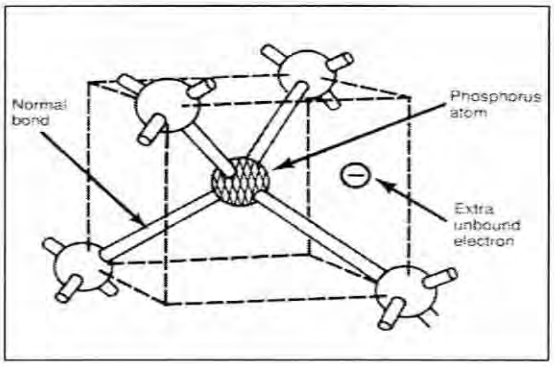

Figure 2.1 Structures of valence electron

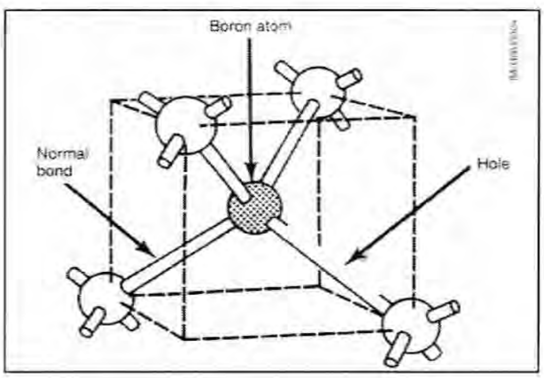

Figure 2.2 Phosphorus ion and silicon

This unbonded valence electron behaves like a permanent member of the crystal's conduction band (Figure 2.1).When numerous phosphorus atoms are substituted for silicon in a crystal, many free, conduction-band electrons become available. The most common method of substitution is to coat the top of a layer of silicon with phosphorus and then heat the surface[14].This allows the phosphorus atoms to diffuse into the silicon. The temperature is then lowered so that the rate of diffusion drops to zero. Other methods of introducing phosphorus into silicon include gaseous diffusion, a liquid dopant spray-on process, and a technique in which phosphorus ions are driven precisely into the surface of the silicon (Figure 2.2).

This n-type silicon cannot form the electric field by itself; it is also necessary to have some silicon altered to have the opposite electrical properties. Boron, which has three valence electrons, is used for doping p-type (positive-type) silicon. Boron is introduced during silicon processing, where silicon is purified for use in PV devices. When a boron atom assumes a position in the crystal lattice formerly occupied by a silicon atom, there is a bond missing an electron--in other words, an extra hole. In p-type material, there are many more positive charges (holes) than free electrons.

Holes are much more numerous than free electrons in a p-type material and are therefore called the majority charge carriers. The few electrons in the conduction band of p-type material are referred to as minority charge carriers. In n-type material, electrons are the majority carriers, and holes are the minority carriers (Figure 2.3).

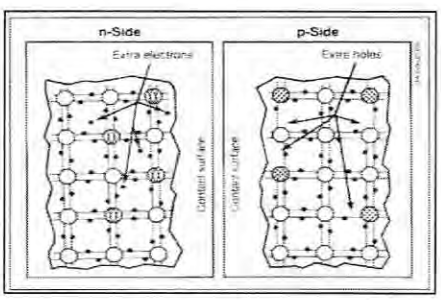

Figure 2.3 N-side and P-side

Both p-type and n-type silicon are by themselves electrically neutral; that is, each material contains an equal number of negatively charged electrons and positively charged protons. The majority charge carriers, however, have excess energy that is not bound up in valence bonding with neighboring atoms. This higher energy allows them to traverse the crystal lattice. The majority carriers--electrons in n-type and holes in p-type silicon are the ones that physically respond to an electric field. Electrons are attracted to and holes are repelled by an electric field (Figure 2.4).

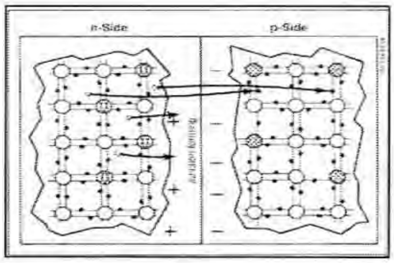

Figure 2.4 Attraction and repelled by electron and holes

Where n-type and p-type silicon come into contact, an electric field forms at the junction (referred to as the p-n interface, or p-n junction). Like floodwaters breaking through a dam, some majority charge carriers on each side rush over to the other side. There are two forces at work in this process. The majority charge carriers are more energetic and more mobile than the minority carriers. They are therefore able to move from where they are highly concentrated across the junction to a lower concentration.

This is called diffusion. In addition, they are attracted (electrically) by the opposite charge of the majority carriers across the junction. In the immediate area of the junction, the "extra" electron from the phosphorus fills the hole across the junction in the boron atom. Holes then overpopulate the immediate vicinity of the interface on the n-type side; electrons overpopulate the p-type side.

This overabundance is true only in the immediate vicinity of the junction, however. The bulk of the n-type silicon is still populated with negative charges; holes remain the majority charge carriers in the bulk of the p-type silicon (Figure 2.5).At equilibrium, when all the charge carriers have settled down again, a net charge concentration exists on each side of the junction.