CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Over the past few years, there was plenty speculation of fuel price hikes, a world energy crisis and concerns of global warming. The increasing demand of energy and the growing concern about the environment has sparked enormous interest in the utilization of renewable energy. For the time being, renewable energy represents only 7% of the global energy consumed and it will slightly increase as the need for the global energy increased (Bose, 2010). One of the alternative energy sources that are recently flourishing is the sun, mainly because it is free, sustainable, environmental friendly and maintenance free.

The sun's energy, which is converted to solar electricity, or photovoltaic (PV), is likely being one of our major energy sources in the near future. PV is energy from the sun, which the light is converted directly into electricity without creating any air or water pollution. It consists of silicon, which going through a doping process to produce positive and negative type semiconductor materials. When light enters the cell, some of the photons from the light are absorbed by the semiconductor atoms, freeing electrons from the cell’s negative layer to flow through an external circuit and back into the positive layer. The main electrical characteristics of a PV cell or module are summarized in the relationship between the current and voltage. The solar radiation that is absorbed by the cell controls the current (I), while the increases in the temperature of the solar cell reduce its voltage (V). A single PV cell is basically a direct current (DC) source, where the current is determined by the area of the cell and the amount of
exposed solar irradiation. One of the examples of the PV module structure is as shown in Figure 1.1.

![Figure 1.1: PV Module construction](image)

Source: Kroposki, Margolis et al. 2009

There was a long list to show a chronological history of solar PV, but it is important to know that in 1839, French scientist, Edmond Becquerel, discovered the photovoltaic effect while experimenting with an electrolytic cell made up of two metal electrodes placed in an electricity-conducting solution; the electricity-generation increased when exposed to light. In 1876, William Adams, a British physicist, discovered a material of photovoltaic which is selenium with his student, Richard Day. They, altogether, then made it to solid cells with 1 % – 2 % efficiency. And in 2008, scientists at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) have achieved a new world record in solar cell efficiency. They managed to get a photovoltaic device have 40.8 % of efficiency. The achievement and evolution in PV industry are really outstanding and exceptional. The PV system is gaining an important as a renewable source due to advantages such as the absence of fuel cost, little maintenance and no noise and wear due to the absence of moving parts. Even though solar energy constitutes a very small percentage of our energy system today, the size of the resource is enormous which we can state that the earth receives more energy from the sun in one hour than the global population uses in an entire year (Kroposki, Margolis et al., 2009).
Although the PV system has many advantages, there are still two major disadvantages to the use of photovoltaic systems; the high installation cost and the lower energy conversion efficiency. Efficiency is the main component in solar PV technology as the solar energy that disappears without converting to electrical energy is considered a loss. As PV installation averagely at a cost of around RM5000/kWp (Ali, 2013), thus every power that loss during the process are costly. The relatively high cost of photovoltaic power systems has required system designers to maximize efficiency wherever possible. Even modest gains in overall efficiency can result in significant savings in the cost of operating the power system. Compared to the cost of electrical energy available from conventional sources the cost of energy from photovoltaic is still fairly high so it is important that the maximum available amount of energy be extracted from the solar array. To maximize the power output of the PV system, a DC/DC converter with an appropriate Maximum Power Point Tracking (MPPT) algorithm is commonly employed within a controller device named Solar Charge Controller. Together, the DC/DC converter and MPPT algorithm control the terminal voltage of the PV system at optimal values in various solar radiation conditions, where at a certain weather condition; the output power of a PV panel depends on the terminal voltage of the system. Figure 1.2 shows the PV system block diagram that works to ensure the PV module operation point always at the MPP.

![PV system block diagram](image-url)

**Figure 1.2:** PV system block diagram from charge controller’s perspective