# SOLAR WATER LEVEL CONTROLLER

**LIM MIN SIANG**

**A thesis submitted in partial fulfillment of the requirements for the awarded of the Degree of Bachelor of Electrical Engineering (Power System)**

**Faculty of Electrical & Electronic Engineering**

**University Malaysia Pahang**

**NOVEMBER, 2010**

I declare that this thesis entitled "SOLAR WATER LEVEL CONTROLLER" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....................................................

Name : LIM MIN SIANG

Date : 29 November 2010

# ACKNOWLEDGEMENT

This project would not have been possible without considerable guidance and support. So, I would like to acknowledge those who have enabled me to complete this project.

Firstly I would like to thank to my project supervisor, En. Ramdan Bin Razali for providing the guideline with continues advice and feedback throughout the duration of finishing this project.

Secondly I would also like to thank for all other University Malaysia Pahang staff members that I may have called upon for assistance since the genesis of this project. Their opinions and suggestions have helped me in realizing this project. Also not to be forgotten, I would like to thank for all my friends with the support, valuable opinion and sharing ideas during the progress of this project.

Finally, I would like to thank to my family for their understanding, encouragement and support, towards the compilation of my project. Grateful that my family members who always stand by my side concerning the ups and downs of my life. Appreciations that can never be express merely in words were delivered to all that contributed effort to my project. Best regards and thanks you

# ABSTRACT

In today's society, the remote area is experiencing a great demand for supplied of water which beyond the reach of power lines. Sunlight, as the keys to a new generation of power sources are widely available for replace the conventional fuel resources. Hence the aim for this project is to module a solar water level controller pump to obtain the water from well or underground water source for the purpose of irrigate crops, water livestock, and provide potable drinking water.

This project calculated and estimated the amount of water delivered depends on distance that water is lifted, distance traveled through a delivery pipe, the efficiency of the pump and the amount of energy needed as the main consideration. With this solar water controller, the remote area residents can enjoy the benefit from the solar energy as the lowest cost and sustainable alternative option with environmental friendly that are not polluting.

# ABSTRAK

Masyarakat pada zaman ini, terutamanya di kawasan pedalaman telah menghadapi satu permintaan yang amat tinggi kepada bekalan air yang jauh daripada litar kuasa. Cahaya matahari, merupakan kunci kepada penjanaan kuasa baru untuk bekalan kuasa yang sedia ada secara luasnya untuk menggantikan sumber bahan api yang konvensional. Oleh hal yang demikian, tujuan untuk projek ini adalah untuk memodulkan pengatur peringkat pam air tenaga suria untuk mendapatkan air dari perigi atau sumber-sumber air bawah tanah untuk tujuan tanaman air, ternakan air, dan menyediakan air minum bersih.

Projek ini mengira dan menganggarkan jumlah air yang dihantar bergantung pada jarak bahawa air yang diangkat, jarak tempuh melalui paip penghantaran, kecekapan pam dan jumlah tenaga yang diperlukan sebagai pertimbangan utama. Dengan pengatur air suria ini, penduduk daerah terpencil dapat menikmati manfaat dari tenaga matahari sebagai kos terendah dan pilihan alternatif yang berterusan dengan mesra alam yang tidak berbahaya.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Alternative energy is commonly used to operate water sourcing equipment in applications including remote water pumping for residential supply, small-scale irrigation and livestock watering. Remote or off-grid power sources—solar panels are specifically design to making great changes in locations where electricity from power lines is unavailable.

The use of PV systems for remote applications is becoming more and more accepted across the world as its advantages over distribution line extension are realized. Therefore, this project proposed for the control of regulator supplying sufficient and reasonable drives for pump system to fully operate in various states from photovoltaic (PV) module. Solar photovoltaic water pumping systems composed of a photovoltaic solar array, a solar charge controller, a motor, a pump and a battery with inverter.

Hence, as future electrical engineer, this is an honor and responsibility to facilitate and share the technology in order to improve their live. This is how the basic idea that leads to this project of solar water level controller. The study and implementation of solar water level controller is believed to be helpful in increase demand of available water supply.

## 1.2 Problem Statement

While water is readily available in developed countries, in developing countries more than 1.2 billion people do not have access to a safe and adequate water supply. Significantly, resident especially in rural area make a three-hour journey just to collect water from the nearest water source such as well and lake and stream. Moreover, the power lines are often unavailable in these deep remote areas due to the high net electricity costs concerns.

## 1.3 Objectives of the project

The vital objectives of this project are:

1. To develop a suitable controller scheme for water level controller based on solar power.
2. To design an efficient solar charger for pump battery here this is less maintenance and long life-span.

## 1.4 Scope of the project

The scope of this project will be mainly focus on develop an efficient solar powered water level controller using AC motor pump system which will consume 14-17V. Besides that, this pump will be using a deep cycle batteries for power supply if solar power is not available. Lastly, a proper controller scheme is designed to supply the correct voltage and current to the pump. The distance between the pump systems to the consumer will also be determined to assure the sufficient water pressure.

## 1.5 Thesis outline

This thesis contains five chapters, which are introduction, literature review, methodology, result, conclusion and recommendations.

Chapter 1 is explaining about the background, objectives, and scopes of the project and overview of the whole chapter.

Chapter 2 provides a literature review on solar system overview in general and discusses about the methods used today to design solar water level controller.

Chapter 3 focuses on the methods that are used for this project including flow chart, and circuit design of the system. Other than that, it also discusses about simulation tool used for this project.

Chapter 4 discusses about the result obtained from the simulation and the results explained in more detail.

Chapter 5 covers the conclusion has made, problems encountered and future recommendations for this project.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter presents an overview of solar system. Solar photovoltaic (PV) system has been recognized as suitable for power generation in countries where there are high levels of solar radiation.

## 2.2 Solar Energy

Sun provided the earth with various energies such as in the form of solar energy, radiant light and heat. These energies have been utilized and develop in the human civilization since ancient times. Across the centuries, many other alternative energy have been discovered and hence competition between the source of energy start from solar radiation to the other resources such as wind energy, wave power, hydroelectricity and also thermal.

Generally, solar powered electrical generation relies mainly on photovoltaic and harvest the solar energy using solar panels. Since the era of "cheap but dirty energy" – fossil fuel resources arise; solar energy's uses are limited only by human ingenuity. List of the solar powered applications includes day-lighting, solar water-heater, solar cooking, solar pump in irrigation and minor use in potable water via distillation and disinfection, high temperature heating process for industrial purposes.

Solar technologies are commonly categorized as either passive solar or active solar depending on the way the energy being captured, converted and distributed. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. [1]

## 2.3 Solar Panel

Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect (this is the photo-electric effect). [8] Theoretically, photons are created in the center of the sun by the fusion of atoms. Then, it takes a photon about a million years to work its way to the surface of the sun, but once free it is hurled through space so fast that it reaches earth in just eight minutes - after traveling 93 million miles. Hence, by using the energy of speeding photons, an electrical current can be created within a solar panel.

The majority of modules use wafer-based crystalline silicon cells or a thin-film cell based on cadmium telluride or silicon. Crystalline silicon, which is commonly used in the wafer form in photovoltaic (PV) modules, is derived from silicon, a commonly used semi-conductor.

In order to use the cells in practical applications, they must be connected electrically to one another and to the rest of the system. Furthermore, it must be protected from mechanical damage during manufacture, transport, installation and use (in particular against hail impact, wind and snow loads). This is especially important for wafer-based silicon cells which are brittle. Finally, it must also be protected from moisture, which corrodes metal contacts and interconnects, (and for thin-film cells the transparent conductive oxide layer) thus decreasing performance and lifetime.

PV array was divided into 3 type of solar cell where most efficient and most expensive type are Monocrystalline, followed by Polycrystalline and the least expensive and least efficient are Amorphous(Thin Film). Figure 2.1 showed the physical image of three types of solar cell.

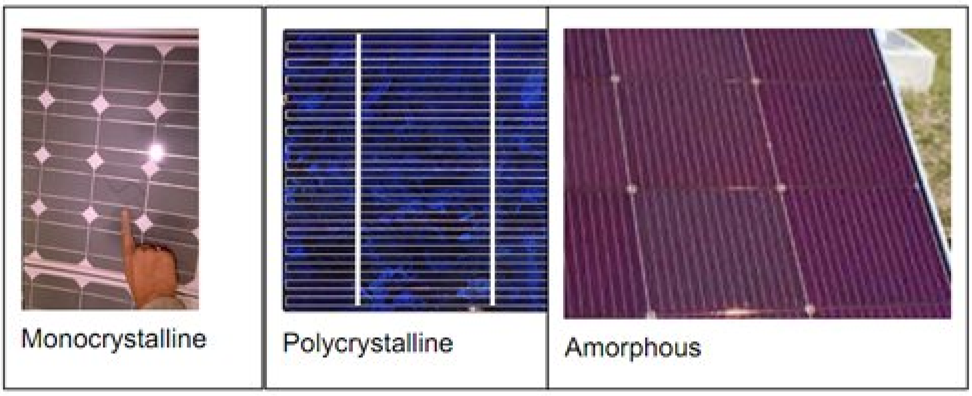


**Figure 2.1** Types of solar panel

Most modules are usually rigid, but there are some flexible modules available, based on thin-film cells. By far, the most prevalent bulk material for solar cells is crystalline silicon (abbreviated as a group as *c-Si*), also known as "solar grade silicon". Bulk silicon is separated into multiple categories according to crystallinity and crystal size in the resulting ingot, ribbon, or wafer.

### 2.3.1 Monocrystalline Solar Panel

Monocrystalline silicon often made using the Czochralski process. Single-crystal wafer cells tend to be expensive, and because they are cut from cylindrical ingots, do not completely cover a square solar cell module without a substantial waste of refined silicon. Hence most monocrystalline panels have uncovered gaps at the four corners of the cells.

### 2.3.2 Polycrystalline Solar Panel

Poly- or multicrystalline silicon made from cast square ingots — large blocks of molten silicon carefully cooled and solidified. Polycrystalline cells are less expensive to produce than single crystal silicon cells, but are less efficient. However, there were a higher number of multicrystalline sales than monocrystalline silicon sales due to the economical cost.

### 2.3.3 Thin Film Solar Panel

Thin-film technologies reduce the amount of material required in creating a solar cell. Though this reduces material cost, it may also reduce energy conversion efficiency. Thin-film silicon cells have become popular due to cost, flexibility, lighter weight, and ease of integration, compared to wafer silicon cells.

Diodes are often included to avoid overheating of cells in case of partial shading. Since cell heating reduces the operating efficiency it is desirable to minimize the heating. Very few modules incorporate any design features to decrease temperature; however installers try to provide good ventilation behind the module.[1]

The power produced by the solar array depends on the weather conditions, the position of the sun and the capacity of the array. At noon on a bright day, a good array can produce over 2 kilowatts (2.6 hp). A 6 $m^2$ array of 20% cells will produce roughly 6 kW·h (22 kJ) of energy during a typical day on the Malaysia weather at daily insolation of 4 hours.

In brief, monocrystalline solar panels are the most efficient commercially viable photovoltaic solar collectors among three types of solar panel. PV panels made from monocrystalline solar cells are able to convert the highest amount of solar energy into electricity of any type of flat solar panel. Consequently, Monocrystalline panels are a great choice for urban settings or where space is limited. Moreover, monocrystalline cell have greater heat resistance where the loss of efficiency is lower than what is typically experienced by polycrystalline cells.

## 2.4 Battery

A battery, in concept, can be any device that stores energy for later use. A rock, pushed to the top of a hill, can be considered a kind of battery, since the energy used to push it up the hill (chemical energy, from muscles or combustion engines) is converted and stored as potential kinetic energy at the top of the hill. Later, that energy is released as kinetic and thermal energy when the rock rolls down the hill.

Common use of the word, "battery," however, is limited to an electrochemical device that converts chemical energy into electricity, by use of a galvanic cell. A galvanic cell is a fairly simple device consisting of two electrodes (an anode and a cathode) and an electrolyte solution. Batteries consist of one or more galvanic cells.

A battery is an electrical storage device. Batteries do not make electricity; they store it, just as a water tank stores water for future use. As chemicals in the battery change, electrical energy is stored or released.

In rechargeable batteries this process can be repeated many times. Batteries are not 100% efficient - some energy is lost as heat and chemical reactions when charging and discharging. If you use 1000 watts from a battery, it might take 1200 watts or more to fully recharge it. Slower charging and discharging rates are more efficient.

### 2.4.1 Starting Battery

*Starting* (sometimes called SLI, for starting, lighting, ignition) *batteries* are commonly used to start and run engines. Engine starters need a very large starting current for a very short time. Starting batteries have a large number of thin plates for maximum surface area. The plates are composed of a Lead "sponge", similar in appearance to a very fine foam sponge. This gives a very large surface area, but if deep cycled, this sponge will quickly be consumed and fall to the bottom of the cells. Automotive batteries will generally fail after 30-150 deep cycles if deep cycled, while they may last for thousands of cycles in normal starting use (2-5% discharge).