THE FEASIBILITY STUDY OF THE IMPLEMENTATION AND UTILIZATION OF PHOTOVOLTAIC AND WIND ENERGY AT TELUK MELANO

MOHD. RIZAL ABDUL RASHID

UNIVERSITI MALAYSIA SARAWAK

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Judul: THE FEASIBILITY STUDY OF THE IMPLEMENTATION AND UTILIZATION OF PHOTOVOLTAIC AND WIND ENERGY AT TELUK MELANO

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APPROVAL SHEET

This project entitled **"The Feasibility Study Of The Implementation And Utilization Of Photovoltaic And Wind Energy At Teluk Melano"** was prepared and submitted by Mohd. Rizal Abdul Rashid as a partial fulfillment of the requirement for the degree of Bachelor of Engineering with Honours in Mechanical and Manufacturing System is hereby read and approved by:

MR. NAZERI ABDUL RAHMAN

(SUPERVISOR)

Date: 22 Oct 2002

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ABSTRAK

Tenaga dari sumber yang boleh dan akan habis telah menyebabkan berbagai masalah seperti pencemaran udara, pemanasan global, risiko nuklear, krisis tenaga dan bermacam-macam lagi. Oleh itu, adalah logik untuk manusia mencari sumber tenaga alternatif. Tenaga dari matahari dalam bentuk langsung atau tidak langsung, seperti tenaga angin, semakin dikenali sebagai sumber untuk menjana elektrik di merata tempat. Bagaimanapun, di Sarawak, bentuk tenaga alternatif ini belum digunakan dengan meluas biarpun di tempat terpencil. Kawasan seperti ini adalah terpisah dari grid nasional dan oleh itu, lebih gemar menggunakan penjana elektrik enjin diesel. Kajian ini adalah bertujuan untuk menentukan sama ada penggunaan tenaga alternatif boleh dijalankan di satu kawasan terpencil iaitu Teluk Melano. Teluk Melano adalah terletak di daerah Lundu, Sarawak. Perkampungan ini terdiri daripada 50 buah rumah, sebuah sekolah rendah dan sebuah balai polis. Satu kajian penggunaan tenaga di Teluk Melano telah dijalankan sebelum satu sistem photovoltaic dan satu sistem turbin angin ditentukan saiznya. Keputusan kajian ini mencadangkan bahawa satu sistem penjanaan elektrik yang berskala besar perlu diadakan sekiranya menggunakan tenaga alternatif tersebut.

ABSTRACT

In view of the many problems such as air pollutions, global warming, nuclear risks, energy crisis and many others associated with the currently available exhaustible energy forms; it is therefore only logical to look for alternatives. Energy from the sun, be it in direct or indirect form such as the wind energy, are getting more recognized in terms of its capabilities in providing sources for electricity generation in many parts of the world. In Sarawak, however, these forms of alternatives have yet to gain much use even in the less densely populated area. These mostly rural areas are disconnected from the national grid and therefore rely mainly on diesel generators for electricity generation. As such, this study will attempt to determine the feasibility of these alternative energies for electricity generation in one such area, Teluk Melano. Teluk Melano is located in the Lundu district of Sarawak. The village consists of 50 houses, a primary school and a police station. An energy consumption study of Teluk Melano has been carried out before sizing of a photovoltaic system and a wind turbine system can begin. The results of this study suggested that a large-scale electricity generator system is required in order to provide electrification by means of alternative energy.

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Roman

A	:	Area normal to the wind (m^2)
C_{Full}	:	Full capacity of battery (Ah at 12V)
C_{T12}	:	Total usable capacity needed (Ah at 12V)
DOD	:	Depth of discharge (%)
E_L	:	Daily requirement of one appliance (Wh)
E_{Mod}	:	Daily output of one module at 12V (Wh)
E_T	:	Total daily power requirement (Wh)
H	:	Duration of daily use (h)
I_{Mod}	:	Module current (A)
N_{Batt}	;	Minimum number of batteries required
N_{Mod}	:	Minimum number of modules required
PHD	:	Peak hours per day (equivalent to kWh/m^2)
P_A	:	Power of appliance (W)
P_{Act}	:	Theoretical actual obtainable power from wind (W)
P_{Atm}	:	Atmospheric pressure (mbar)
P_{Max}	:	Theoretical maximum obtainable power from wind (W)
P_{Wind}	:	Power from wind (W)
R_{TB}	:	Radius of wind turbine blade (m)
T	:	Temperature (°K)
T_{Day}	:	Period of storage required (days)
u_W	:	Wind velocity (m/s)

Greek

ρ : Density of air (kg/m^3)

ζ_{BC} : Battery charging efficiency (%)

ABBREVIATIONS

AC	Alternating current
DC	Direct current
NA	Not available
PV	Photovoltaic

CHAPTER 1

INTRODUCTION

With the advancement of society and its surroundings, the need for electricity energy arises steadily for developing countries like Malaysia. It is however economically unfeasible for electricity to be supplied to the whole nation by means of a national grid alone. There will always be rural areas that are too remote and cut-off from the grid; and therefore could not be connected to the grid (not economically justifiable anyway), and yet with enough population convinced of the need for electricity. Providing these rural areas with conventional power plant is totally out of the question, and so in many cases, diesel gen-sets have been employed to produce the much-needed power. However, with awareness towards the availability (or unavailability) of fossil fuel in the indefinite future and also the environmental impacts caused such as global warming, acid rain and generally, air pollution; it is only right that one should consider the many alternatives of clean yet non-depletable energy.

The sun has always been life's main energy source in the form of light, thermal and more recently, electricity. The direct approach of generating electricity from the sun is by harnessing the radiant energy transmitted by the sun (photovoltaic effect) whereas the indirect category is when the sun's energy is transform into a different form such as the wind, and will therefore be manipulated in that form to produce electricity.

1.1 Solar Energy

Solar energy has been used for thousands of years to many ends from the drying of food to its usage as fuel. With its enormous capacity, this abundance resource has been utilized all over the world to generate electricity to homes in remote areas. According to *Solar Electric Light Fund* (2001), approximately 400,000 families in the developing world are already using small, household solar photovoltaic systems to power fluorescent lights, radio-cassette players, 12 volt black-and-white TVs, and other small appliances. These families, living mostly in remote rural areas, already constitute the largest group of domestic users of solar electricity in the world.

The abundance of solar energy available in the atmosphere makes this method of electrical energy conversion very promising. According to *Schwaller & Gillberti* (1996), researchers at the United States Department of Energy has noted that on a global scale, the amount of solar energy that arrives in a two-week period is equivalent to the fossil energy stored in all the known reserves of coal, oil and natural gas. They also claimed that the total amount of solar energy striking the earth's atmosphere in a year is equivalent to 35,000 times the energy used annually by humans. These are the enticing capabilities of the solar energy that should humans be capable of capturing and utilizing this energy fully, there will be no more global energy shortage. **Figure** 1-1 shows the global photovoltaic usage since 1971 with projection to 2005. The steady increment of photovoltaic usage clearly shows that this form of energy generation is getting popular by the year and will contribute significantly to the power generation of the future.

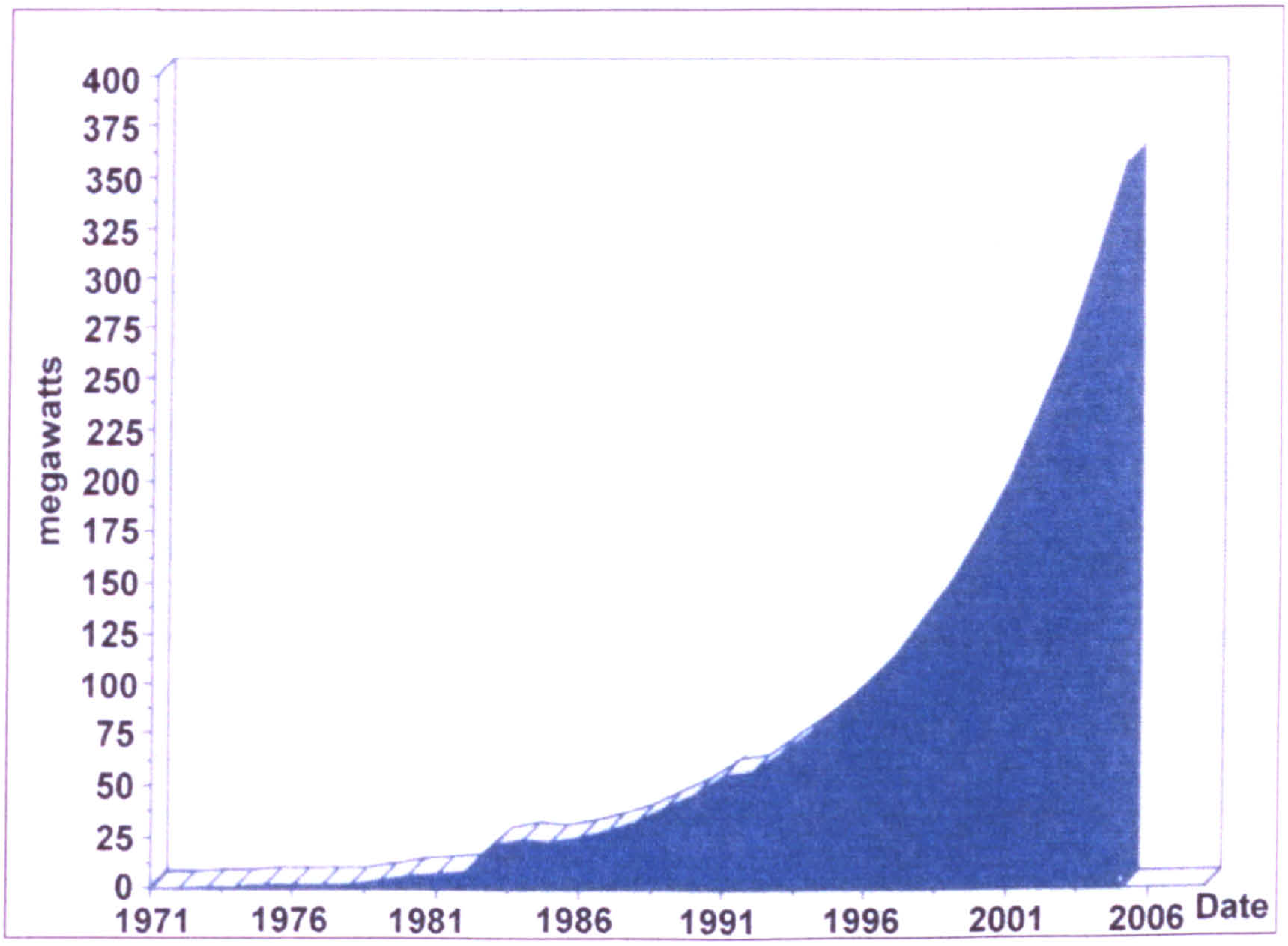

Figure 1-1: World Photovoltaic Usage (megawatts), 1971 with projections to 2005 [*Schwaller & Gilberti, 1996*]

1.2 Solar Photovoltaic System

A solar photovoltaic system is a system that converts direct solar energy into electricity. The electricity is either used to power appliances or charge batteries for used when no direct sunlight is available. Such a system can either be an individual system (used in individual residential) or a grid connected, to power a larger size community.

1.2.1 Photovoltaic Fundamentals

Solar energy can be converted directly into electricity by means of a photovoltaic system. This can be achieved by utilizing the solar cell, which reacts to the light from the sun by energizing the photons in proportion to the intensity and spectral distribution of the sunlight. When their energy level reaches a certain level, a potential difference, or open circuit voltage, is established across the cell. This in turn drives a current through an external load. According to *Derrick, Francis & Bokalders* (1994), almost all modern photovoltaic devices use silicon as the base material mainly as mono-crystalline or multi-crystalline cells but also in amorphous form. As shown in **figure 1-2**, a mono-crystalline silicon cell is made from a wafer thin high purity silicon crystal, doped with a minute quantity of boron. Phosphorous is diffused into the active surface of the wafer. A metallic grid makes the front electrical contact and the back usually covers the whole surface. An anti-reflective coating is applied to the front surface. According to *Solstice* (2001), modern solar cells can convert approximately 12 per cent of the solar energy they receive into electrical